REMEDIAL INVESTIGATION WORK PLAN

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
PATRICK BAYOU SUPERFUND SITE, DEER PARK, TEXAS

Prepared for

U.S. Environmental Protection Agency

and the

Patrick Bayou Joint Defense Group

Prepared by

Anchor Environmental, L.L.C.

1011 DeSoto Street

Ocean Springs, Mississippi 39564

January 2007

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The Patrick Bayou Remedial Investigation Work Plan includes the following documents under one cover:

- Project Management Plan
- Quality Assurance Project Plan
- Data Management Plan
- Health and Safety Plan

Anchor	Anchor Environmental, L.L.C.
AOC	Administrative Order on Consent
ASTM	American Society of Materials and Testing
BAF	bioaccumulation factor
BSAF	Biota-sediment accumulation factor
CLP	Contract Laboratory Program
cm	centimeter
COC	chain-of-custody
COPC	chemical of potential concern
CPT	cone penetrometer test
CRZ	contaminant reduction zone
DM	Data Manager
DMP	Data Management Plan
DQO	Data Quality Objective
EDD	electronic data deliverable
EDF	East Property Flare
EE/CA	Engineering Evaluation/Cost Analysis
ESRI	Environmental Systems Research Institute
FFS	Focused Feasibility Study
GIS	Geographic Information Systems
HASP	Health and Safety Plan
HSC	Houston Ship Channel
HSM	Health and Safety Manager
IDL	instrument detection limit
JDG	Patrick Bayou Joint Defense Group
LPM	Laboratory Project Manager
MDL	method detection limit
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
OSHA	Occupational Health and Safety Administration
PAH	polynuclear aromatic hydrocarbons
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity

PC	Project Chemist
PCB	polychlorinated biphenyls
PFD	personal flotation device
PM	Project Manager
PMP	Project Management Plan
POC	point of contact
PPE	personal protective equipment
ppm	parts per million
PQL	Practical quantitation limit
PSCR	Preliminary Site Characterization Report
QA/QC	quality assurance/quality control
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QEA	Quantitative Environmental Analysis, L.L.C.
RI/FS	Remedial Investigation/Feasibility Study
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SDG	sample delivery group
Site	Patrick Bayou Superfund Site in Deer Park, Texas
SOP	Standard Operating Procedures
SOW	Statement of Work
SPT	standard penetrometer test
TCEQ	Texas Commission on Environmental Quality
TDL	target detection limit
TMDL	total maximum daily load
TNRCC	Texas Natural Resource Conservation Commission
TPDES	Texas Pollutant Discharge Elimination System
TRPP	Texas Risk Reduction Program
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

PROJECT MANAGEMENT PLAN
REMEDIAL INVESTIGATION WORK PLAN

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1 INTRODUCTION

This document outlines the proposed approach for the Remedial Investigation/Feasibility Study (RI/FS) for the Patrick Bayou Superfund Site (Site), Deer Park, Texas. The RI/FS is being performed by the Patrick Bayou Joint Defense Group (JDG), which entered into an Administrative Order on Consent (AOC) with the U.S. Environmental Protection Agency (USEPA), Region 6 on January 31, 2006. The JDG is comprised of the following corporations: OxyVinyls, Shell, and Lubrizol. The JDG has contracted de maximis as a project coordinator and facilitator for the project and Anchor Environmental, L.L.C. as the primary RI/FS contractor. Other contractors working as part of the RI/FS team include Newfields for strategic decision analyses, Quantitative Environmental Analysis, L.L.C. (QEA) for hydraulic and sediment transport analyses, and Gahagan and Bryant for bathymetric and surveying support. An analytical laboratory will be selected and qualifications provided at a later date. A general organization chart for the project is provided in Figure 1-1. A summary of qualifications for each firm and resumes for key personnel are provided in Appendix A.

The Site, shown in Figure 1-2, is a tidally influenced bayou and tributary to the Houston Ship Channel that has been significantly modified to also function as a drainage for municipal and industrial discharges (a designated use for the Site). A description of the Site, its history, a summary of historical data, and a preliminary Conceptual Site Model are provided in the Preliminary Site Characterization Report (PSCR) (Anchor 2006a), and in the Response to Comments on the PSCR (Anchor 2006b). The text below provides a very general overview of the Site based on analyses performed for the PSCR.

There are a large number of historical environmental investigations and data associated with the Site, especially with regards to Total Maximum Daily Load (TMDL) investigations relating to sediment toxicity, dissolved copper concentrations in surface water, ambient water toxicity, and surface water temperature. In addition, other investigations were performed by the City of Houston, the Texas Natural Resource Conservation Commission (TNRCC) (later known as the Texas Commission on Environmental Quality (TCEQ), and the USEPA. These investigations and their data show that sediments at the Site are impacted by a variety of potential contaminants including polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, metals including mercury, dioxins and furans, hexachlorobenzene, and hexachlorobutadiene among others.

The Site is complicated by the fact that it drains large off-site surface areas under dynamic conditions. These conditions are governed by intense thunderstorms and other precipitation events that produce large amounts of runoff and substantially increased flow amounts and velocities. There is an apparent reflection of these dynamic conditions in the historical sediment chemistry and toxicity data that in some cases shows variations that are above those that might be expected by simple sediment heterogeneity or depositional patterns under more quiescent conditions.

A preliminary summary of complete and significant pathways and receptors that will be evaluated in the RI/FS risk assessment for the Site are shown in Figures 1-3 and 1-4. In addition to potential historical and ongoing upstream surface water contaminant sources, shallow groundwater, surface water, air emissions, and other upland sources that enter into the Bayou from adjacent industrial facilities (Figure 1-5) have the potential to impact the Site. Impacts associated with these potential sources are being addressed under applicable TCEQ regulatory programs for each of the industrial facilities that surround the Bayou. The intent of the RI/FS team is to integrate the findings of each of the facilities' TRRP programs as they relate to potential impacts to Site surface water, sediments, and ecological and human receptors. The facilities' contractors and the RI/FS team will work together to identify data gaps that may exist and identify data quality objectives, sampling plans, and roles and responsibilities for filling those data gaps as the project moves forward.

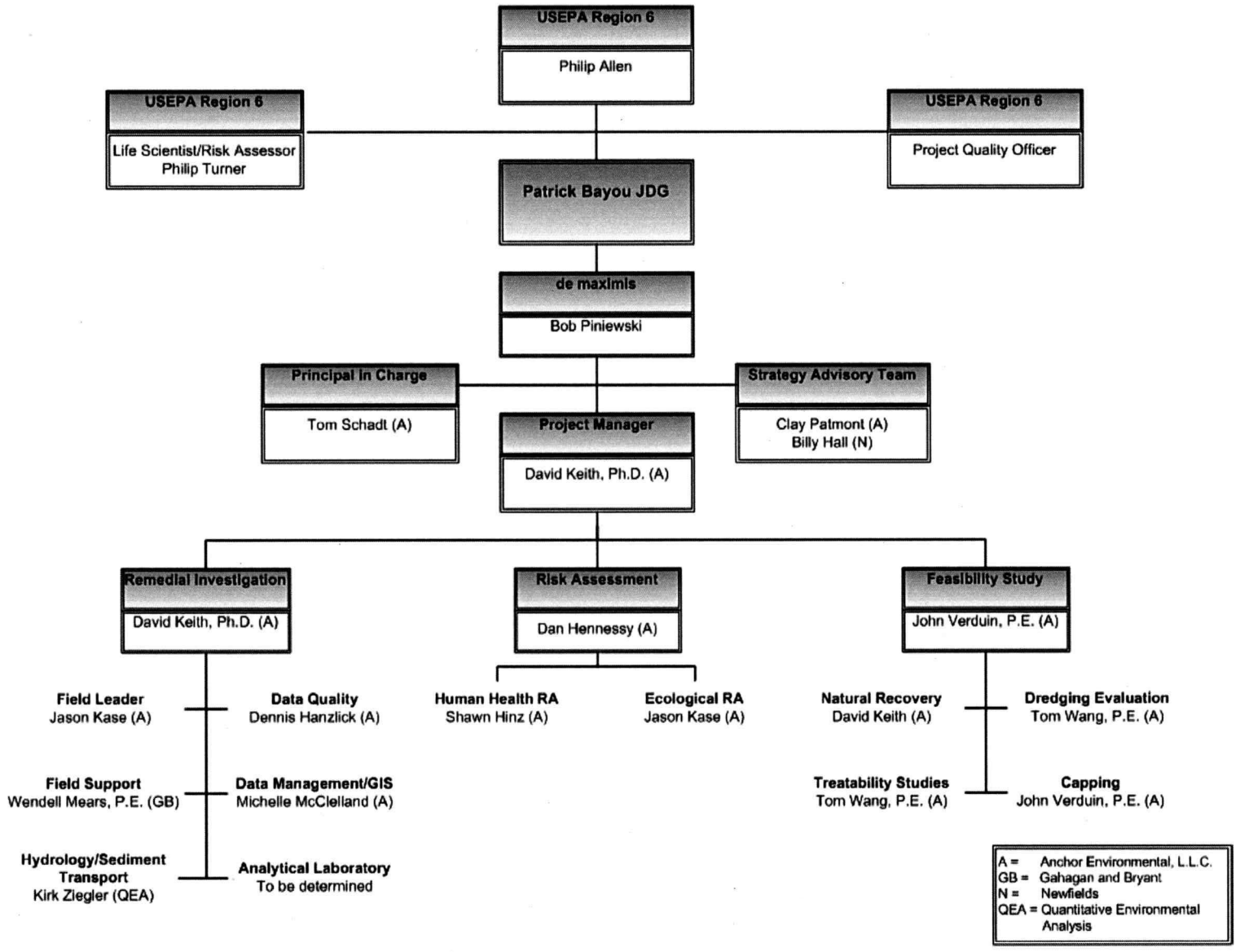

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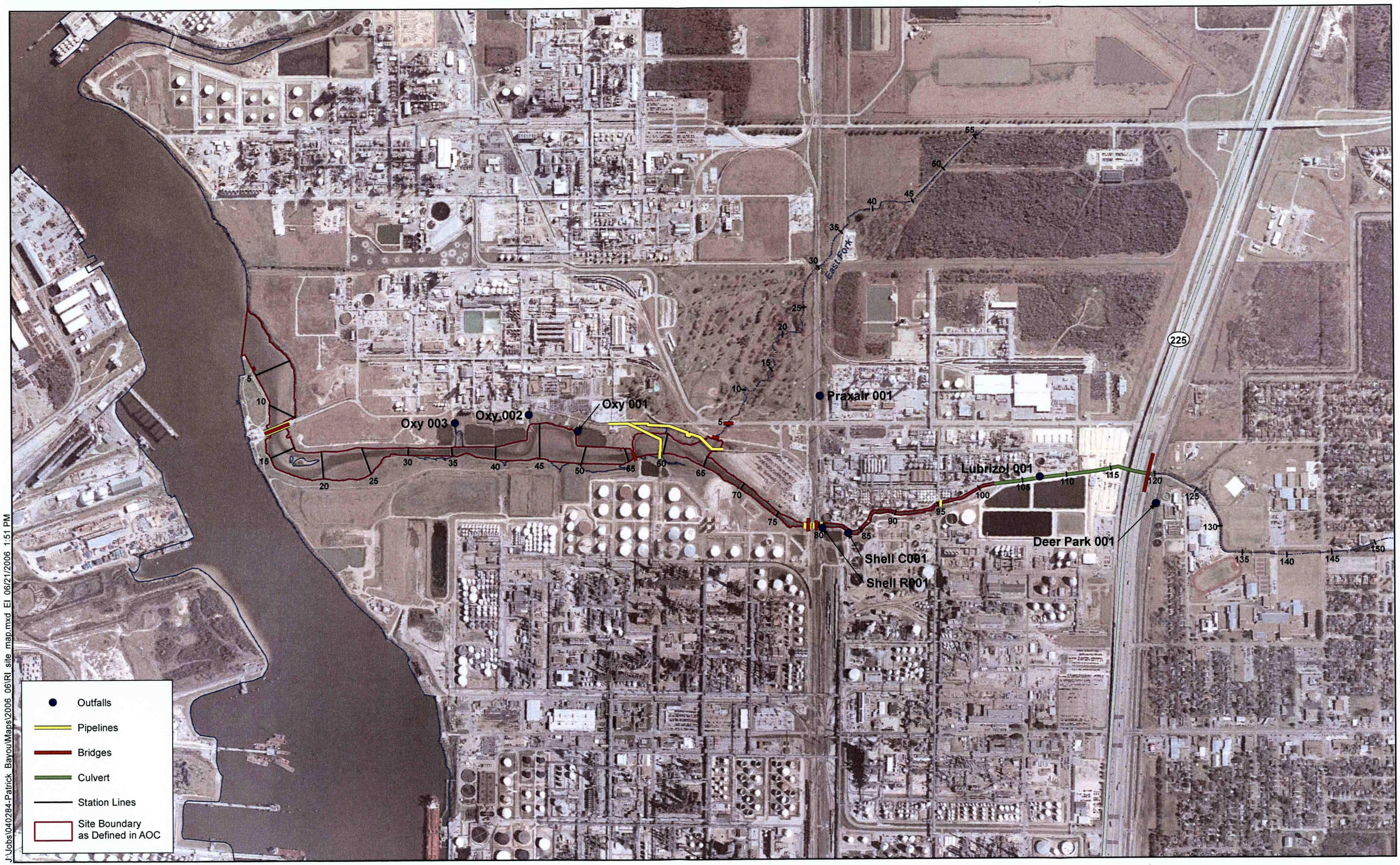
Figure 1-1
Project Organization Chart
Patrick Bayou RI Work Plan



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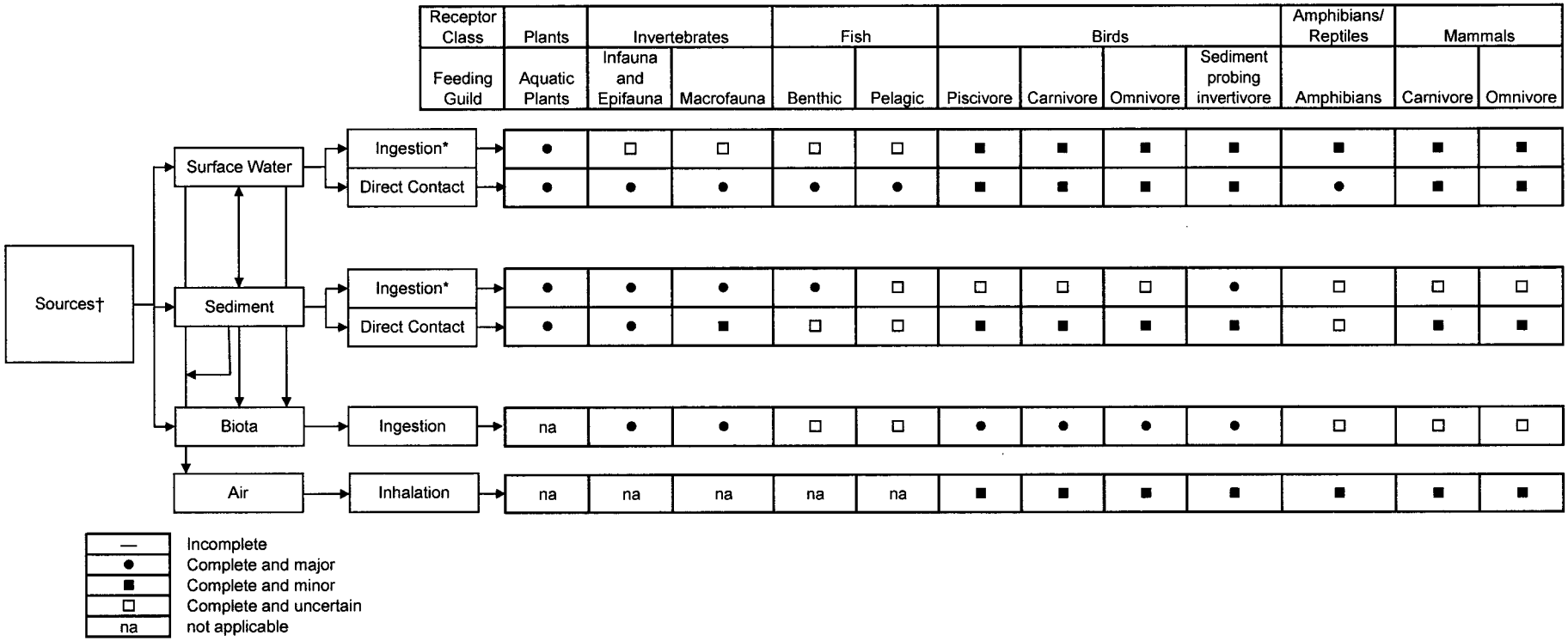
Bridges and pipelines from GBA Survey, May/June 2005.
Outfalls and culvert approximated from aerial orthoimagery and historical maps.
Stations are placed in 500-foot intervals. Station numbers indicate length along channel in hundreds of feet.
Aerial orthoimagery from USGS, June 2002.

Figure 1-2
Patrick Bayou Superfund Site Map
Patrick Bayou RI Work Plan



* For aquatic plants, uptake is considered the route of exposure
†See Figure 1-5 for contaminant sources and transport

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Figure 1-3
Ecological Receptor Groups and Habitat Features
Patrick Bayou RI Work Plan

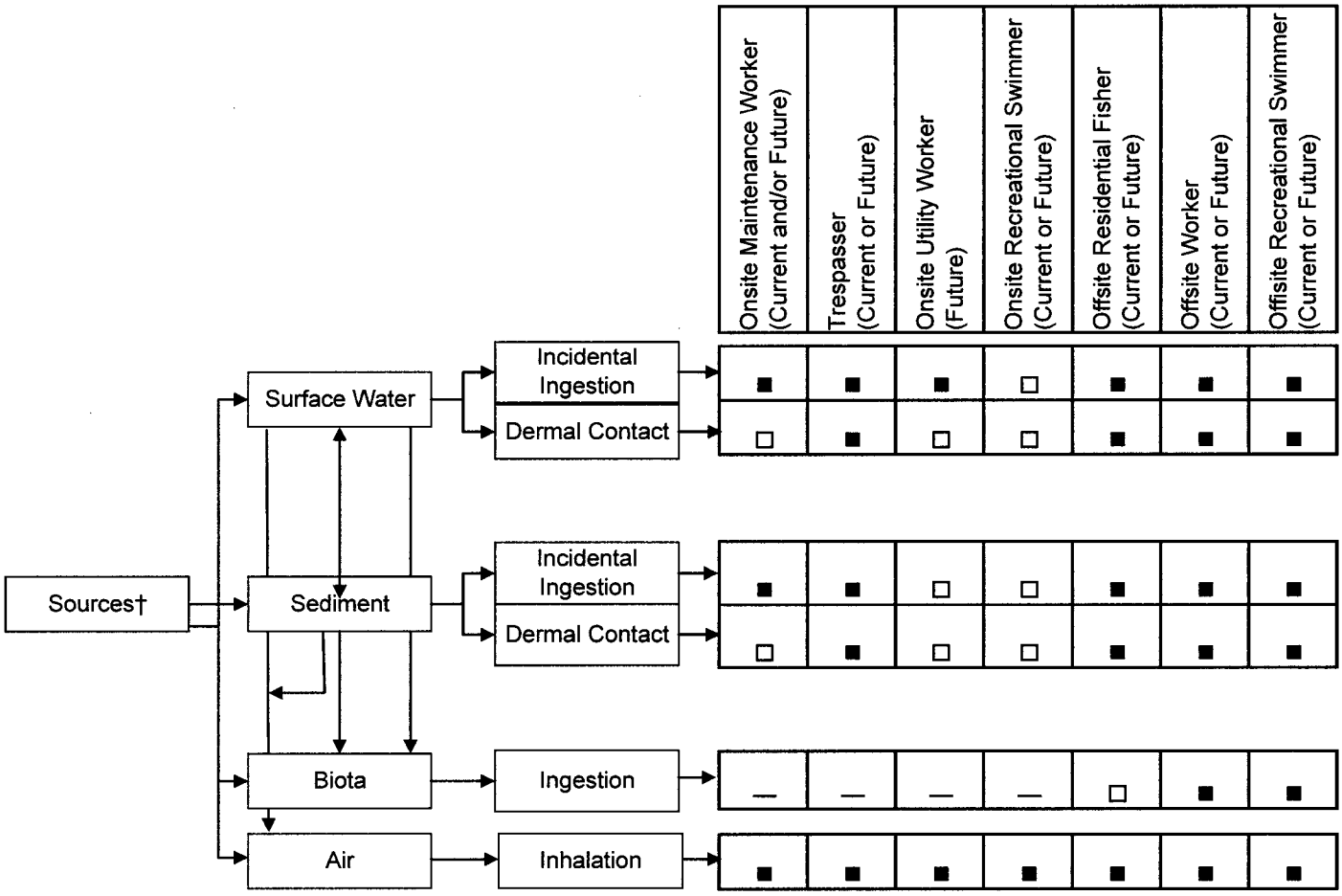

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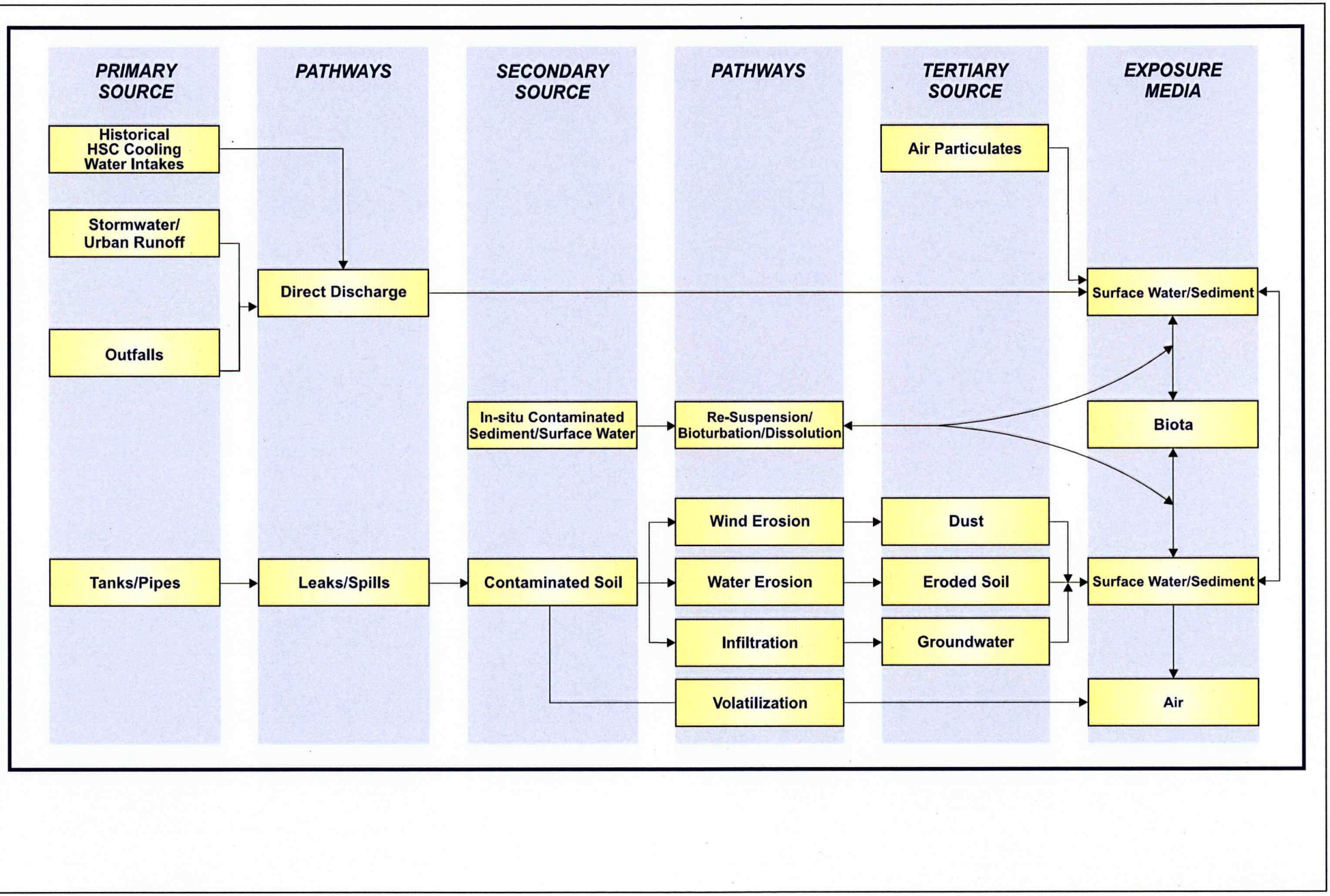
Figure 1-4
Preliminary Human Health Conceptual Model for Patrick Bayou
Patrick Bayou RI Work Plan



6/27/06 CVD K:\Jobs\040284-PATRICK BAYOU\04028401\FIG 1-5 PMP.cdr

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Figure 1-5
Sources, Transport, and Media in Relation to Physical Features of the Site
Preliminary Site Characterization Report

2 RI/FS PROCESS OVERVIEW

As outlined in the PSCR (Anchor 2006a) and USEPA's approval of the RI/FS Approach letter dated June 7, 2006, Anchor will undertake an adaptive management approach to the RI/FS process, whereby work is completed, results are evaluated, the understanding of the Site updated, and future work plans are revised as appropriate. The order of future work will be prioritized so that existing and new data are complementary and leveraged towards building a better conceptual understanding of the Site and a remedial solution for the Site. All future work will occur in phases and each phase of work will be fully described in either work plans or Sampling and Analysis Plans (SAPs) for USEPA review and approval prior to initiation.

The RI/FS team will continually evaluate existing and newly collected data to determine if there are opportunities for early remedial actions and/or controls that would significantly reduce risk posed by the Site, or if there is an opportunity to move the project from the traditional RI/FS path into an Engineering Evaluation/Cost Analysis (EE/CA), or Focused Feasibility Study. Section 300.415(b)(4)(i) of the NCP requires completion of an EE/CA for all non-time-critical removal actions (NTCRA), with the objective of an EE/CA to:

- Identify removal action objectives for the protection of human health and the environment
- Identify NTCRA cleanup alternatives
- Assess the effectiveness, implementability, and cost of the alternatives

If appropriate, performance of an EE/CA could provide an appropriate response, which would allow for meeting the project objectives in an expedited and efficient manner.

This document and the associated Quality Assurance Project Plan (QAPP) (Anchor 2006c), Data Management Plan (DMP) (Anchor 2006d), and Health and Safety Plan (HASP) (Anchor 2006e) provide administrative and programmatic direction for the project and are the foundation of subsequent work packages (either Work Plans or SAPs) in a phased RI/FS approach. If needed, addenda to the HASP and other global plans will be prepared for each SAP to cover activities outside of the scope of the global documents.

Work packages will be prepared detailing a specific investigation or other work that will occur. This process will continue until the RI is completed. Based on a review of the considerable

amount of historical data that is available for the Site and other information presented in the PSCR (Anchor 2006a), the work packages anticipated for the Patrick Bayou RI include the following:

- Work Package 1 – Historical Data Quality Assessment Work Plan and Identification of Preliminary Data Quality Objectives (DQOs) and Contaminants of Potential Concern (COPC). The Work Plan for this Work Package has been submitted to USEPA and was approved on July 7, 2006.
- Work Package 2 – Hydrology and Source Evaluation
- Work Package 3 – Ecological and Human Health Risk Assessment
- Work Package 4 – Feasibility Study Engineering Data

The focus of each of these work packages are discussed in more detail in Section 3. During preparation of each work package, and after the evaluations of data associated with each work package are completed, Anchor will provide interim reports to the JDG and agencies to keep team members apprised of the progress of the project. Anchor will also integrate the interim reports into a complete RI report at the end of the process.

The FS process will be conducted in a similar manner, with the following major phases:

1. Feasibility Study Work Plan
2. Feasibility Study Data Collection
3. Feasibility Study Data Analysis
4. Feasibility Study Report

The focus of the FS work plan and data collection will be to fill any data gaps in regards to evaluating potential remedial options and designs on geotechnical and hydrodynamic bases and determining the locations of potential waste handling/disposal facilities.

3 SAMPLING AND ANALYSIS PLAN/QUALITY ASSURANCE PROJECT PLAN

Based on the phased or adaptive management approach, Anchor will prepare a SAP for specific sampling events associated with subsequent work packages. The general QAPP (Anchor 2006c) describes the project objectives and organization, functional activities, and quality assurance and quality control (QA/QC) protocols that will be used to achieve the desired DQOs for each phase of the work. In addition, the QAPP addresses sample custody, analytical procedures, data reduction, validation, and reporting.

Task specific SAPs will be submitted separately to the JDG and USEPA for approval prior to implementation of any field activities as the need arises. The SAPs will define in detail the DQOs and sampling and data gathering methods that will be used for the project to define the nature and extent of contamination, ecological/human health risk assessment, and FS-related evaluations. At a minimum, each SAP will include a discussion of sampling objectives, sample location and frequency, sampling equipment and procedures, and sample handling and analysis. The SAP will be written so that a field sampling team unfamiliar with the Site would be able to gather the samples and field information if required. Anchor will refer to USEPA's guidance document titled *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988), which describes the RI/FS SAP format and the required content.

Anchor will demonstrate in advance, to USEPA's satisfaction, that each analytical laboratory it may use is qualified to conduct the proposed work. This includes use of methods and analytical protocols for the chemicals of concern in the media of interest within detection and quantification limits consistent with both QA/QC procedures and the DQOs approved in the RI/FS QAPP for the Site by the USEPA.

4 WORK PACKAGES

As discussed in Section 1, the planned RI work will be divided into the Work Packages discussed below. The work will be conducted in the general order presented below.

4.1 Work Package 1 – Historical Data Quality Assessment and Identification of Preliminary DQOs and COPCs

The Work Plan for this Work Package has been submitted to USEPA and was approved on July 7, 2006. The purpose of the work is to validate and verify that the existing environmental data available for the Site are acceptable to support subsequent efforts associated with the RI/FS risk assessment process. This work will include the development of performance and acceptance criteria for existing data and set specific requirements for reviewing, describing, evaluating, categorizing, and documenting the existing data. It will describe the inputs and outcomes of the data verification/validation and preliminary data quality review tasks and will identify the specific acceptance criteria and measurement quality objectives that were evaluated.

The results of this work will include a summary of the data verification and validation, documentation of what was populated into the database, exceptions and issues (e.g., high detection limits or missing information), and statistical summaries.

Additionally, this work package will include an evaluation to identify preliminary COPCs and DQOs using the existing historical data. Risk-based approaches will be used to identify chemicals in abiotic media that should be further evaluated in subsequent planning and sampling activities (e.g. Work Package 2). This assessment will be conducted using conservative exposure assumptions, with the purpose of identifying key exposure pathways on which to focus more detailed analyses and identifying potential data gaps to be addressed in the screening-level and baseline ecological risk assessment. Approaches to address direct exposure and bioaccumulation will be described, including assumptions regarding exposure pathways and receptors.

4.2 Work Package 2 – Hydrology and Upstream Source Evaluation

This work will include a detailed Work Plan and field work to develop an understanding of the sediment transport mechanisms and the erosion and depositional characteristics of

Patrick Bayou. In addition, a source evaluation that focuses on evaluating potential ongoing contaminant contributions from off-site sources upstream of Highway 225 and the East Fork will be part of this effort. To provide a point of reference for comparing ongoing contaminant sources to historical loading, the depositional history and temporal nature of contaminant sources will be evaluated in this phase by vertically profiling the Site sediments for bulk and radio chemistry. There is no existing information concerning the vertical distribution of preliminary COPCs in Site sediments. Developing an understanding of the vertical distribution of preliminary COPCs is important for several reasons, including:

- Vertical characterization will help determine if COPC sources are primarily associated with historical discharges, or if there are significant ongoing sources. If COPCs identified are primarily related to historical discharges, one would expect that the largest mass of those COPC to be associated with deeper sediments.
- Vertical characterization will also help focus RI and FS evaluations on those areas that pose the greatest risks for contaminated sediment exposure and transport.

Work Package 2 will also include development of a quantitative model to evaluate the sediment and contaminant transport. The data will assist in development of future field studies and provide an overall understanding of the hydraulics within the environment of Patrick Bayou for both the RI and FS. This work may include additional phases depending on the outcome of the initial evaluation. The JDG will utilize QEA, a firm that specializes in characterizing and evaluating sediment transport, to assist Anchor for this phase of work.

4.3 Work Package 3 – Ecological and Human Health Risk Assessment

Initially, in order to determine whether potential contaminants in sediment, water, or biota could pose an unacceptable risk to ecological or human health receptors, the scope fo work for additional data collection tasks required pertaining to risk assessment will be developed and implemented in this phase of the project.

Anchor will then develop a Work Plan for agency review to perform the ecological risk assessment and human health risk assessment in accordance with the appropriate USEPA guidance documents (USEPA 1989, 1997, 1998a, 1998b) and other relevant and required documents and guidance as outlined in the AOC and will interact closely with the USEPA's Remedial Project Manager and risk assessment staff assigned to the Site. The scope of the

ecological and human health risk assessments will be determined through a phased approach as outlined in the USEPA's guidance documents. The most clearly apparent data needs or exploratory data collection surveys necessary to refine future data needs are discussed below.

4.3.1 Physical Data

A comprehensive spatial and temporal survey of physical water quality parameters, primarily salinity, temperature, and dissolved oxygen, will be conducted to evaluate the effect of such parameters on the observed distribution of biota within Patrick Bayou. This information will provide insight into factors that potentially control temporal changes in the benthic community, delineate the transition between freshwater and estuarine habitat, and support the design of sampling plans related to potential ecological receptors.

4.3.2 Biological Data

Habitat mapping and biota reconnaissance surveys will be conducted to characterize the potential receptors and the exposure to the Site. Habitat mapping is expected to include identifying the size, location, type, and quality of wetlands, shoreline, and other habitats at the Site. Mapping and characterizing the size and nature of the intertidal and subtidal zones will be conducted to determine the foraging area available to avian and upland receptors, as well as the area available to aquatic receptors to inhabit the Site. A recent comprehensive bathymetric survey for Patrick Bayou has been performed; however, comprehensive surface water elevations and tidal characteristics within the Bayou are not well characterized. A survey of water levels within the Bayou over time will be completed to perform the evaluation.

An understanding of the receptors present within Patrick Bayou is critical to developing a representative site conceptual model (SCM) that clearly identifies relevant exposure pathways and receptors. Reconnaissance surveys of aquatic and wildlife receptors at the Site will be completed to provide important information in selecting appropriate assessment endpoints for the risk assessment. The survey of aquatic receptors will focus on identifying both potential ecological receptors and the use of the Site by fish and shellfish resources available for human consumption.

4.3.3 Toxicity Data

Previous investigations have identified toxicity in Site sediment using bioassay testing methods. However, attempts to characterize the source of toxicity to test organisms were inconclusive (as described in the PSCR). As such, additional bioassay work is not expected to reduce the uncertainty in assessing risks to ecological receptors and is not currently included in the expected data generating activities for the RI.

4.3.4 COPC Sampling

A robust characterization of chemical concentrations in sediment, water, and biota is critical to assessing risks to ecological and human health receptors. Although a great deal of historical data on chemical concentrations in Site media are available, several apparent data gaps have been initially identified based on expected risk assessment data needs. The list below includes the most apparent data collection needs based on the PSCR (Anchor 2006a). Certain data collected during Work Package 2 may preclude further data collection in Work Package 3. They include:

- **Sediment** – Although surface sediments have been extensively sampled in Patrick Bayou, there is some uncertainty in the usability of historic data to characterize exposure of ecological receptors to the Site. Sampling designs for many of the existing studies (TNRCC and USEPA 1996, USEPA 2001, Parsons et al 2002, Parsons et al 2004) included bias in the sampling locations based on proximity to Texas Pollutant Discharge Elimination System (TPDES) outfalls. Randomly selected locations (Parsons et al 2002 and 2004) were collected from the centerline of the channel, but characterization of the nearshore environment was not included. In addition, USEPA 2001 included surface sample depths all in excess of 10 centimeters (cm), which may not accurately characterize the exposure to ecological receptors. As such, the Work Plan will describe a comprehensive review process to identify samples that can be used to characterize exposure of ecological receptors to the Site. For example, additional sampling of the ecologically relevant (0 to 10 cm) sediment surface will be necessary to address risk assessment needs at the Site. The Work Plan will include the development of a sampling program designed to address data gaps in the existing data for characterizing exposure of receptors to sediment.

- **Surface water** – The most recent comprehensive survey of water quality in Patrick Bayou was performed in 1994 (TNRCC and USEPA 1996). Although routine monitoring has been performed subsequent to this study, the scope of monitoring has been spatially limited and the list of analytes included may not be adequate to characterize risks to receptors. The Work Plan will include the development of a sampling program designed to address data gaps in the existing data for characterizing exposure of receptors to surface water.
- **Biota** – A significant data gap exists due to the lack of tissue chemistry in Patrick Bayou. Tissue data allow direct measurement of site-specific concentrations to which wildlife may be exposed via fish and shellfish consumption. Site-specific data will be collected and is expected to significantly reduce the uncertainty in the exposure assessment, as compared to the use of literature-based Biota Sediment Accumulation Factor (BSAF) and Bioaccumulation Factor (BAF) values to estimate exposure. In addition to the collection of site-specific tissue, collecting regional tissue samples will allow comparison to appropriate Galveston Bay-wide background tissue burdens. The Work Plan will include the development of a sampling program designed to address data gaps in the existing data for characterizing exposure of receptors to biota. Sample design and strategy for this portion of the Work Plan will incorporate the results of the scoping-level risk assessment and additional data collected during Work Package 2.

In addition to the collection of analytical chemistry data for the different media at the Site, chemical characterization of Site media related to the bioavailability, fate, and toxicity of potential Site contaminants will be collected to reduce the uncertainty in the exposure of receptors to Site contaminants. The Work Plan will include the development of a sampling program designed to address data gaps in the existing sediment chemistry data for the following analytes:

- **Methyl mercury** – Methyl mercury is an organic form of mercury and is the most easily bioaccumulated form of mercury. Mercury biomethylation is primarily carried out by sulfate reducing bacteria in anoxic sediments. Previous studies in Patrick Bayou performed total mercury analysis in sediments. Other forms of mercury do not bioaccumulate as efficiently as methyl mercury, and using total

mercury to estimate exposure and bioaccumulation in biota may result in an overestimate of mercury exposure. Characterizing methyl mercury in sediments will reduce the uncertainty in the bioaccumulation potential of mercury in Site sediments.

- **PAHs** – Equilibrium partitioning is an approach to developing site-specific concentrations of PAH mixtures that are protective of the benthic organisms. This approach accounts for the varying bioavailability of PAH in sediments with different organic carbon content, allowing for a site-specific assessment of potential effects to benthos. The use of this approach typically necessitates an expanded list of PAH analytes in sediment over the typical list of PAHs included in sampling programs (USEPA 2003). Use of the expanded list of PAHs is recommended for this application, because the USEPA (2003) procedure requires that substantial uncertainty factors are applied when the number of PAHs in the dataset is limited.
- **PCB Congeners** – Historical Site data is based on PCB Aroclors, commercial mixtures of PCB compounds. There are two primary issues to consider when identifying the need for Aroclor- or congener-based PCB analysis at a Site: 1) analytical advantages and 2) toxicity assessment. Although analytical costs may be significantly higher, PCB congener analysis frequently provides some advantages over Aroclor-based analysis, including lower detection limits and avoiding coelution interference. Use of PCB congener-specific data in risk assessment has advantages over Aroclor-based risk assessments in that the former approach avoids some uncertainties in the assessment of toxicity for PCBs. A significant part of the toxicity associated with commercial PCB mixtures is related to the presence of a small number of planar PCB congeners. These compounds induce several similar toxic effects in mammals and birds such as hepatotoxicity, immunotoxicity, and reproductive toxicity. Planar halogenated aromatic compounds act, in part, by a common mechanism initiated by binding to a cytosolic aryl hydrocarbon receptor. The relative toxicities of planar halogenated hydrocarbons can be expressed by their toxicity in relation to 2,3,7,8-TCDD, the most potent compound in this class of chemicals. As such, PCB congener analysis will be considered during subsequent work package

development and will reduce the uncertainty in the toxicity assessment for Site receptors.

4.4 Work Package 4 – Feasibility Study Engineering Data

The evaluation of remedial alternatives requires a variety of geotechnical data that are specific to different remedial technologies. The data needs for the most likely potential remedial technologies that will be evaluated in this phase of work are described below. The actual data that will be collected as part of this Work Package is dependant on several factors, including the availability of existing data, data collected as part of Work Packages 1 and 2, and an assessment of potential remedial alternatives at that time.

4.4.1 Monitored Natural Recovery

Monitored Natural Recovery is defined by USEPA as a "sediment cleanup method that uses ongoing, naturally occurring processes to contain, destroy, or otherwise reduce the bioavailability or toxicity of contaminants in sediment." The USEPA defines natural processes as the following physical, biological, or chemical mechanisms that reduce risks associated with the COPCs in sediment:

- Physical processes – sedimentation, advection, diffusion, dilution, bioturbation, and volatilization
- Biological processes – biodegradation, biotransformation, phytoremediation, and biological stabilization
- Chemical processes – oxidation/reduction, stabilization, and sorption

Natural attenuation and recovery may be accomplished by a variety of mechanisms, including sedimentation, dispersion, and COPC sequestration and/or degradation. The assessment of each of these mechanisms requires different data that may be collected as part of the RI. Generally, those data may be collected for evaluation of the following:

- Surface sediment concentration of COPCs
- COPC concentration profiles with depth (Work Package 2)
- Sediment loading
- Settling rate of suspended sediment
- Concentration of COPCs and constituents that inhibit mobility of COPCs on suspended sediment

- Hydraulic characteristics that affect net sedimentation
- COPC degradation characteristics

4.4.2 Containment Methods

Capping is a generic term for the in-situ containment of contaminated sediment. Contaminated sediments are covered (capped) by an appropriate material that isolates the contaminants from the water body and from ecological and human receptors.

Capping involves the placement of a natural material such as sand, gravel, or a synthetic material on top of the contaminated sediment, thereby isolating chemicals from the overlying water. A cap will therefore prevent receptors from having direct contact with chemicals in the sediment, as well as prevent or substantially decrease the fate of flux of chemicals from the underlying sediments. In addition, a cap will prevent resuspension and downstream migration of chemicals adsorbed onto suspended sediment.

The assessment of containment methods, such as in situ capping, requires information on the energy of the surface water flow in the area of interest, the mobility and concentrations of COPCs in the native sediment, and the strength and grain size of the native sediment. These data are used to evaluate potential capping materials for their resistance to erosion and their resistance to the flux of COPCs through the cap. The strength and grain size of the native sediment is required to assess the ability of the sediment to support the cap and to select the proper gradation of capping materials. There is some pre-existing information on grain size data, but there is no information on other geotechnical properties of the native sediment in Patrick Bayou.

In addition, potential capping materials may be tested if there is a promising source of capping material located near the Site. The tests of potential capping materials would include: settling rate, grain size and geotechnical index properties, and COPC concentrations. The distance from the potential borrow areas to the areas to be capped are also important to the evaluation. As an alternative to the active placement of capping material, hydraulic modifications to the Bayou may allow utilization of natural sedimentation as the in situ capping method.

4.4.3 Sediment Removal

Dredging technologies can generally be placed into one of four broad categories (mechanical, hydraulic, pneumatic, and specialized). The evaluation of remedial alternatives that involve sediment removal requires information about the area to be excavated/dredged and the disposal sites. Dredging technologies will require evaluation of the following factors:

- Sediment Resuspension – The resuspenion characteristics of a dredging technology determine how well the contractor can meet the requirements of water quality standards. If water quality standards cannot be met during construction, the contractor may have to change procedures or switch to a different technology, which could result in delays and additional costs. Poor sediment resuspension characteristics could also result in reduced production rates, slowed construction, and the spread of contaminants.
- Availability – Availability of technology can determine its feasibility.
- Site Compatibility/Technical Feasibility – To be technically feasible, a technology needs to be compatible with the site characteristics, including sediment volumes to be dredged, water depths, channel widths, and the presence of structures, obstructions, and debris.
- Solids Content – The solids content of the dredged material affects subsequent technologies, including transport, treatment, and disposal. If large amounts of water are added to the sediments during dredging, the solids content decreases. For off-site disposal options that include transport by truck, rail, and barge, as well as for treatment, it is generally beneficial if the sediments can be dredged near the in-situ solids content. However, if the dredged material is to be disposed in an on-site confined disposal facility (CDF) and the material is transported there by pipeline, it may not be an issue to pump the material as a slurry at a relatively low solids content.
- Production Rate – The dredging production rate affects the construction schedule and costs. Production rates often vary widely by dredging technologies and depend heavily on Site conditions such as the presence of debris, obstructions, and structures, as well as water depth.
- Past Performance – The performance of a technology on other, similar dredging projects can be used as an indicator of how the technology would perform.

The measurements required for this evaluation include:

- For potential sediment removal areas:
  - Bathymetric survey
  - Geotechnical index properties
  - Strength properties
  - Bulking properties
  - Elutriate tests
  - COPC concentrations below the anticipated removal depth
- For potential disposal areas:
  - Geotechnical index properties
  - Settlement properties
  - Strength properties

As discussed above, there is substantial pre-existing information on the concentration of COPCs in the shallow sediments and some grain size data, although additional characterization will be required in some areas. The following section identifies the geotechnical tests that may be required.

4.4.4 Geotechnical Tests

Specific geotechnical field measurements and tests that are required to evaluate dredging and capping alternatives include:

- **Geotechnical Index Properties.** Atterberg limits, water content, grain size, specific gravity, and bulk density will be measured on selected samples representative of the range of sediment conditions in the potential dredge areas. These data will be used to predict:
  - The behavior of the sediments during removal
  - Correlated strength of the sediment in source removal and cap areas
  - Volume and bulking of sediments in the remedial area
- **Settlement Properties.** Undisturbed sediment samples will be tested to evaluate settlement from placing caps over in situ sediments. Settlement properties are also required to properly size, design containment berms for, and predict the behavior of caps over aquatic confined disposal areas. Total settlement and time

rate of settlement will be evaluated through laboratory testing of undisturbed sediment samples.

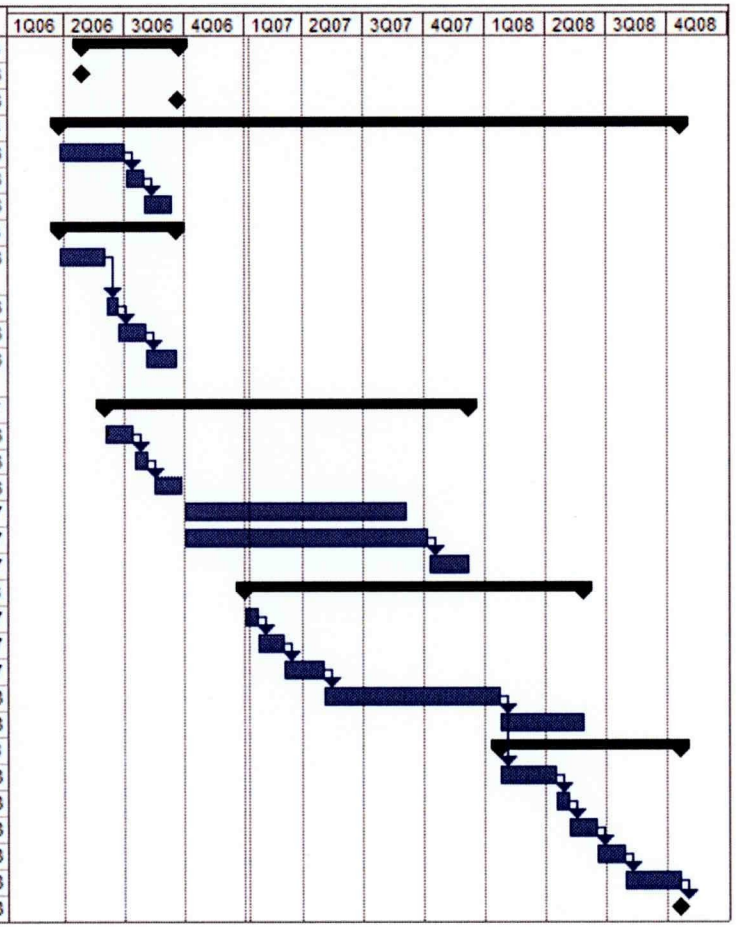
- **Bulking Properties.** Column settling tests and geotechnical index properties will be used to evaluate bulking of removed source material during excavation/dredging. Bulking information will facilitate sizing the disposal facility, if necessary, and will enhance the understanding of the type of equipment required. If the size of the disposal facility is constrained, the settling tests will provide an indication of the possible rate of disposal, which could dictate the removal rate and affect the cost and feasibility of the alternatives.
- **Strength Properties.** In situ strength of the sediments will be measured using field vane shear equipment. This information will be used to evaluate acceptable cap lift thickness and to design containment berms for the confined disposal facility. This information will also be used to help specify side slopes in removal areas. Strength will also be correlated to geotechnical index parameters and will be measured using laboratory tests on undisturbed samples if necessary.

5 SCHEDULE

According to the Statement of Work (SOW), the RI/FS Work Plan is due 150 days after submittal of the PSCR. The final Work Plan is due within 60 days after receipt of USEPA comments on the draft. This schedule would have a Draft Work Plan submittal due around September 29, 2006. The RI/FS team has developed a more aggressive schedule as part of our recommended phased approach. A draft schedule in the form of a Gantt chart for the entire RI, including submittal of Work Plans, field work activities, and reports is provided in Figure 5-1.

This schedule and scope may change substantially in regards to risk assessment and FS tasks if the team decides to pursue EE/CA or FFS type solutions as new information becomes available. The scope, order of the tasks, and schedule outlined above may also change as new information about the Site is collected and analyzed as part of the adaptive management approach. Decisions on any scope or schedule changes will be thoroughly discussed with the project team and approved by USEPA before implementation.

ID	Task Name	Duration	Start	Finish
1	**Preliminary Site Characterization Report (PSCR)**	**106 days**	**Fri 4/28/06**	**Fri 9/22/06**
2	Submit PSCR to Agencies	1 day	Fri 4/28/06	Fri 4/28/06
3	Agency Approval of PSCR	1 day	Fri 9/22/06	Fri 9/22/06
4	**Remedial Investigation**	**673 days**	**Fri 3/24/06**	**Tue 10/21/08**
5	Prepare General RI Workplan	71 days	Fri 3/24/06	Fri 6/30/06
6	JDG Review - RI Workplan	21 days	Mon 7/3/06	Mon 7/31/06
7	EPA Review - RI Workplan	30 days	Tue 8/1/06	Mon 9/11/06
8	**Work Package #1**	**128 days**	**Fri 3/24/06**	**Tue 9/19/06**
9	Historical Data Quality Assessment and Identification of COPC and DQO Workplan	51 days	Fri 3/24/06	Fri 6/2/06
10	JDG Review - Data Quality Assessment Workplan	14 days	Mon 6/5/06	Thu 6/22/06
11	EPA Review - Data Quality Assessment Workplan	30 days	Fri 6/23/06	Thu 8/3/06
12	Draft RI Database Finalization and Identification of Preliminary COPC and DQO	33 days	Fri 8/4/06	Tue 9/19/06
13	**Work Package #2**	**396 days**	**Fri 6/2/06**	**Fri 12/7/07**
14	Phase I Hydrology and Source Evaluation Workplan	31 days	Fri 6/2/06	Fri 7/14/06
15	JDG Review - Phase I Hydrology and Source Evaluation Workplan	15 days	Mon 7/17/06	Fri 8/4/06
16	EPA Review - Phase I Hydrology and Source Evaluation Workplan	30 days	Tue 8/15/06	Mon 9/25/06
17	Phase I Hydrology and Source Evaluation Field Investigation	241 days	Mon 10/2/06	Mon 9/3/07
18	Phase I Hydrology and Source Evaluation Data Analysis	265 days	Mon 10/2/06	Fri 10/5/07
19	Draft Phase I Hydrology and Source Evaluation Report	45 days	Mon 10/8/07	Fri 12/7/07
20	**Work Package #3**	**367 days**	**Tue 1/2/07**	**Wed 5/28/08**
21	Phase I Ecological and Human Health Risk Assessment Workplan	14 days	Tue 1/2/07	Fri 1/19/07
22	JDG Review - Phase I Eco/Human Health Risk Assessment Workplan	28 days	Mon 1/22/07	Wed 2/28/07
23	EPA Review - Phase I Eco/Human Health Risk Assessment Workplan	45 days	Thu 3/1/07	Wed 5/2/07
24	Phase I Eco/Human Health Risk Assessment Field Investigations	190 days	Thu 5/3/07	Wed 1/23/08
25	Draft Ecological and Human Health Risk Assessment Report	90 days	Thu 1/24/08	Wed 5/28/08
26	**Work Package #4**	**194 days**	**Thu 1/24/08**	**Tue 10/21/08**
27	Phase I FS Engineering Data Workplan	60 days	Thu 1/24/08	Wed 4/16/08
28	JDG Review - FS Engineering Data Workplan	14 days	Thu 4/17/08	Tue 5/6/08
29	EPA Review - FS Engineering Data Workplan	30 days	Wed 5/7/08	Tue 6/17/08
30	FS Engineering Data Collection	30 days	Wed 6/18/08	Tue 7/29/08
31	FS Engineering Data Analysis	60 days	Wed 7/30/08	Tue 10/21/08
32	Draft FS Engineering Data Report	0 days	Tue 10/21/08	Tue 10/21/08



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 5-1
Project Implementation Schedule
Patrick Bayou RI Work Plan

6 REFERENCES

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APPENDIX A

QUALIFICATION OF KEY PERSONNEL

DAVID KEITH, Ph.D., R.G., C.H.G.

Project Management/Sediment Scientist

EDUCATION

Ph.D. Geochemistry, 1994, Colorado School of Mines, Golden, Colorado
M.S. Geology, 1991, University of Southern Mississippi, Hattiesburg, Mississippi
B.S. Geology, 1983, North Carolina State University, Raleigh, North Carolina

PROFESSIONAL REGISTRATION AND MEMBERSHIP

Visiting Assistant Professor, University of Southern Mississippi
California Registered Geologist, License No. 7232
California Certified Hydrogeologist, License No. HG 73
OSHA 40-Hour Health and Safety Training (with annual updates)
OSHA 8-hour Health and Safety Supervisor Training

PROFESSIONAL EXPERIENCE

Dr. Keith has directed and participated in numerous projects involved in remediating sites environmentally impacted by contaminated surface water, groundwater, soils, sediments, and other geologic materials, and in addressing problems associated with nonpoint source pollution in stormwater runoff. He has conducted hydrogeologic investigations at local and regional scales, geochemical evaluations of contaminated sediments, soils, industrial wastes, and mining wastes, and developed data analysis tools using geographic information system technology. Dr. Keith has participated in remedial investigations and feasibility studies at RCRA/CERCLA sites, preparation of Environmental Impact Statements/Environmental Assessments as required by NEPA, and in the design of reclamation and closure plans for mine and other industrial sites.

Dr. Keith has worked on several projects involved in evaluating the distribution and the potential ecological impacts of contaminated sediments in lakes, streams, and estuaries throughout the United States. He has exceptional expertise in the use of numerical geochemical models for determining the fate and transport of contaminants in aquatic environments. He has performed water quality evaluations in regards to dredging, capping, natural recovery, and disposal options for a variety of contaminants. Contaminants of concern have included metals and a variety of organic chemicals (non-aqueous phase liquids, polychlorinated biphenyls, dioxins and furans, and pesticides). He has developed soft sediment sampling techniques using piston-coring technology that produces excellent core recovery and allows for centimeter-scale analysis of impacted sediments. Dr. Keith has also developed sediment porewater sampling techniques that utilize dialysis membrane technology for measuring *in situ* water quality in sediments.

REPRESENTATIVE PROJECT EXPERIENCE

Patrick Bayou Remedial Investigation/Feasibility Study

Dr. Keith was the technical lead/project manager for superfund site investigations of tributary to the Houston Ship Channel that is surrounded by three major industrial manufacturing facilities. The project involves multiple potential contaminant phases and sources, and significant hydrodynamic concerns. Specific tasks involve development of site conceptual model, and development and implementation of remedial investigation and feasibility study workplans.

Campbell Shipyard Remedial Design

Dr. Keith was the project manager for Site remedial alternatives analyses, technical analyses for the site Environmental Impact Report, and for preparing engineering design documents for the San Diego Unified Port District remediation project at the former Campbell Shipyard. The design involves placing a clean habitat cap over contaminated sediments that contain constituents of concern (COCs) at concentrations greater than cleanup levels. The habitat cap will isolate contaminated sediments from the marine environment, and provide clean habitat for flora and fauna. Specific team tasks included providing design specifications for construction of the habitat cap, upgrading the shoreline (bulkhead) structures, re-locating a storm drain that currently discharges to the site, designing the dredge and fill portions of the project, providing support in obtaining all necessary State and Federal permits, designing and documenting habitat enhancement opportunities, and providing construction oversight. There is a large component of agency and public outreach associated with the project.

Bayou d'Inde Site, Calcasieu River and Estuary, Lake Charles, Louisiana

Dr. Keith served as the technical reviewer/advisor for providing FS, remedial design, and integrated natural resource damage (NRD) services to group of PRPs on Bayou d'Inde of the Calcasieu River/Estuary located in Lake Charles, Louisiana. EPA previously performed a RI and risk assessment of the larger river/estuary area, and identified Bayou d'Inde as a primary area of concern. A group of PRPs with facilities on Bayou d'Inde entered into an agreement with the State of Louisiana to conduct follow-on FS and remedial design activities at the Site. Anchor is providing a wide range of project management and technical services for the project, including further development of the site conceptual model, delineation of areas of interest, development of remediation goals and objectives, detailed risk assessment and NRD assistance.

NAPL Water Quality Evaluation, Vancouver Shipyard, British Columbia

Dr. Keith was the principal environmental scientist for the evaluation of water quality impacts associated with dredging sediments contaminated with non-aqueous phase liquids (NAPL) in an active shipyard. The project involved characterization of sediments

containing up to 1.3% polycyclic aromatic hydrocarbons, developing dredge management units and developing dredge elutriate test procedures to account for NAPL behavior. Modified U.S. Army Corps of Engineer DREDGE modeling procedures were also developed to predict water quality at the point of dredging, and for areas downstream. Best management practices for dredging were developed and analyzed in the DREDGE model. These data were used to evaluate potential ecological responses that could result from NAPL release under different scenarios.

Stege Marsh Toxic Hot Spot Evaluation, Richmond, California

Dr. Keith was the project manager/principal environmental scientist for assessment of site impacted by weathering by-products of pyrite cinder landfill, fuels, proprietary pesticides, solvents, and alum generated at a former chemical processing facility undergoing site closure and redevelopment on San Francisco Bay. This work was done for a large industrial client under the direction of *de maximis* serving as a project coordinator. Dr. Keith led the development and implementation of field investigations of soils, sediments, and waters in upland chemical plant property and areas within Stege Marsh, recreated a site history spanning a period of 85 years using aerial photographs and company documents, and performed detailed geochemical and hydrogeologic analysis to develop a site conceptual model. The model explained the generation and migration of sulfuric acid, metals and other contaminants into Stege Marsh. The conceptual model was utilized to develop performance specifications for a passive bio-reactor treatment system for groundwater. A comprehensive remedial system design, including excavation and neutralization of reactive cinder landfills materials, was developed and successfully presented to the governing Regional Water Quality Control Board.

Halby/Potts Site Investigation, Wilmington, Delaware

Dr. Keith was the project manager/principal environmental scientist for evaluation of contaminant sources and migration pathways in adjacent State Superfund/chemical processing facilities undergoing site closure and redevelopment near the Port of Wilmington, Delaware. The investigation consisted of developing and implementing a comprehensive site investigation to evaluate sediments and groundwater in an estuarine marsh system. The primary purpose of the investigation was to evaluate contaminant distribution and develop a contaminant source allocation for the responsible parties. Primary contaminants of concern included arsenic, lead, carbon disulfide, petroleum coke, and other petroleum product derivatives. He utilized detailed sediment sampling techniques and advanced geochemical analysis of materials including x-ray diffraction, scanning electron microscopy, and stable isotope analyses, along with bulk geochemical analyses to identify specific phases associated with waste from each of the former chemical processing facilities. Contaminant allocation negotiations and subsequent remedial actions were successfully completed.

CLAYTON R. PATMONT
Partner/Senior Scientist

EDUCATION
M.S. Applied Sciences, Civil Engineering, 1979, University of Washington
B.S. Aquatic Sciences, 1977, Cornell University

PROFESSIONAL EXPERIENCE
Mr. Patmont has more than 19 years of experience in remedial investigation/feasibility studies (RI/FS), contaminant transport modeling, risk assessments, and design of hazardous waste remediation. He has extensive project experience in both CERCLA (Superfund) and Washington State MTCA cleanups. He has directed or managed more than 50 soil and sediment assessment and remediation studies, most of which were conducted with considerable regulatory review.

Mr. Patmont has developed a particular expertise integrating the various technical and regulatory concerns posed by individual projects into cost-effective, reasonable strategies and plans which have been approved under both state and federal environmental programs. His particular expertise in a wide variety of soil, water and sediment quality assessments, and in presenting and evaluating the balance between risk reduction and cost of alternative cleanup remedies (the "practicability" evaluation), has been instrumental in the success of these efforts.

REPRESENTATIVE PROJECT EXPERIENCE
Whatcom Waterway Sediment Cleanup, Bellingham, Washington.

Clay is currently managing a RI/FS for Georgia-Pacific West (G-P) of the Whatcom Waterway, a relatively large sediment cleanup site located in Bellingham Bay. The project has included detailed site characterization, bioaccumulation assessments, sediment/contaminant transport modeling, and cleanup and restoration design. Clay is also sediment cleanup and disposal site task leader on the related Bellingham Bay Demonstration Pilot Project designed to expedite sediment remediation and natural resource restoration on a regional basis, including multi-site cleanup and multi-user disposal facilities. The project has been extremely successful, and is expected to be used as a model for sediment cleanup and restoration decision-making in Washington State and throughout the Northwest.

West Eagle Harbor Sediment and Upland Cleanup, Bainbridge Island, Washington.

Mr. Patmont was project manager of pre-design and design phases of this combined upland cleanup, sediment cleanup, and habitat restoration project. Representing several Potentially Responsible Parties (PRPs) identified at this Superfund site, Clay led the PRP efforts to develop, permit, and design an alternative cleanup and restoration solution. He was able to reduce the cost for design and construction in the West Harbor to approximately $4 million, far below the EPA's original cleanup estimate of $15 to $20 million. The West Harbor cleanup and Schel-chelb habitat construction projects were completed ahead of schedule and within budget in 1997.

Quendall Terminal—Lake Washington, Renton, Washington.

Clay Patmont is the sediment project manager reviewing the proposed cleanup of a wood treatment facility located on Lake Washington. The sediments at the facility have PAH and wood waste contamination. Clay was able to demonstrate that contaminated sediment areas previously selected for removal and upland disposal could be more cost effectively remediated using solutions such as natural recovery, enhanced natural recovery, or *in situ* capping.

Manchester Annex Upland and Sediment Cleanup, Manchester, Washington.

Clay Patmont was technical director of a remedial investigation/feasibility study performed for the U.S. Army Corps of Engineers at this former Navy facility. Clay performed detailed human health and ecological risk assessments using toxicity bioassays and chemical testing of key target resource species including clams, geoducks, and sea cucumbers. The final cleanup and natural resource restoration action approved for the site includes a cost-effective combination of different technologies, including limited removal of debris and "hotspots" in the marine portion of the landfill; engineering of a hydraulic barrier to forestall further leaching; restoration of a dynamic equilibrium beach system on the landfill face; and enhanced natural recovery and restoration of intertidal shellfish beds.

U.S. Navy Site A Remediation, SUBASE, Bangor, Washington.

Clay was project manager of RI/FS, remedial design, and construction oversight elements of this upland soil and groundwater remediation project for the Navy. Site A is a federal NPL site, and was prioritized for cleanup under the Superfund (CERCLA) program. The cleanup plan for the site addresses metal and explosive contaminants in soil, sediment, surface water, and groundwater at the site. Site A was the first Navy Superfund site within the Northwest region to reach an interagency Record of Decision (ROD) for final site cleanup, requiring formal acceptance of the plan by EPA and Ecology. The final cleanup remedy for the site utilizes an innovative and relatively low-cost passive soil washing and leachate treatment/recycling system. Treatability studies were completed to verify the effectiveness of the soil washing and UV/Oxidation leachate treatment technologies, and to optimize cost-effectiveness of the final design. Construction was completed in 1994.

Pier 64/65 Sediment Remediation, Seattle, Washington.

Mr. Patmont was project manager and technical director of an evaluation of sediment quality and remediation options appropriate to this nearshore waterfront area. Sediment quality and contaminant transport conditions were characterized through detailed sediment sampling and sediment trap deployments. The alternative selected for remediation of this site was thin-layer capping, successfully constructed in late 1993.

THOMAS H. SCHADT
Partner

EDUCATION
M.S. Fisheries, 1985, University of Washington
B.S. Fisheries, 1978, University of Washington

PROFESSIONAL EXPERIENCE
Mr. Schadt, a senior aquatic scientist at Anchor Environmental, has 25 years experience in environmental consulting, including nationwide experience with sediment remediation. Mr. Schadt's major area of focus is sediment cleanup projects, investigating water and sediment quality and biological affects, and developing strategies for sediment remediation and habitat restoration. His sediment project experience includes CERCLA, RCRA, state-led and voluntary action sites. Much of his project management experience is with sediment management issues, sediment characterization, cleanup strategy development, feasibility study development, long-term monitoring, and Natural Resource Damage Assessments. Mr. Schadt has participated in sediment cleanup projects in both freshwater and marine environments, including rivers, lakes, estuaries, bayous and bays.

REPRESENTATIVE PROJECT EXPERIENCE

Portland Harbor Superfund Site – Willamette River, Portland, Oregon

Mr. Schadt currently serves as the project manager for the Feasibility Study component of Superfund site on the Willamette River. Mr. Schadt works for a multi-party PRP group that includes 10 + members. The feasibility study work includes evaluating early action opportunities within the 6.5 mile reach of the river that encompasses the site, developing remedial action objectives for the site, and identifying disposal opportunities for contaminated sediments that will potentially be dredged from the site. In addition to the Feasibility Study manager role, Mr. Schadt helps the group develop their long-term strategy for maneuvering through the entire CERCLA process. Mr. Schadt has facilitated the development of a road map that captures major milestones throughout the project, objectives for each milestone, technical strategies and issues that need to be resolved to achieve the objectives, and general cost estimates for the various phases of work associated with each milestone. Mr. Schadt works closely with the PRP group's co-managers in presenting key project issues to EPA and other agencies/Trustees providing the regulatory oversight on the project.

Lavaca Bay RI/FS - Point Comfort, Texas.

Mr. Schadt was the project manager at a CERCLA site in the Gulf of Mexico where the taking of certain species of fish and shellfish was prohibited due to elevated mercury levels in fish tissue. The remedial investigation integrated sediment chemistry studies, biological effects studies, tissue concentration monitoring, and a variety of physical oceanography monitoring to develop a cleanup approach for the site. Concurrent with the CERCLA process, NRDA injury

assessments were made using the RI data set, and restoration planning is taking into account various possible remedial solutions at the site. The Feasibility Study included a dredging treatability study that evaluated the effectiveness of sediment removal from the standpoint of residual surface concentrations following the removal action. The Record of Decision for the site was completed in December, 2001, and the draft Consent Decree is in review. Mr. Schadt will oversee the design of the three remaining remedial actions: 1) capping a portion of the site; 2) dredging a portion of the site; and 3) monitored natural recovery over the majority of the site. Mr. Schadt will also oversee the long-term sediment and tissue monitoring components of the Consent Decree that will be used to evaluate remedy success.

RCRA Sediment Investigation and Cleanup – Lake Charles, Louisiana

Mr. Schadt is the project manager evaluating remedial alternatives to address hexachlorobenzene, hexachlorobutadiene and metals impacted sediments in a wastewater canal system for a facility in Lake Charles, Louisiana. Remedial measures being investigated include natural recovery, in situ capping, removal, and subaqueous disposal. Anchor completed a field sampling program to support the engineering analyses for the different alternatives. Anchor is responsible for developing potential remedial measures, recommending a preferred measure, completing a Corrective Measures Work Plan, and preparing the remedial design Plans, Specifications, and Estimate package.

Bayou d'Inde Corrective Action Study – Lake Charles, Louisiana

Mr. Schadt is the project manager for a multi-party PRP group leading the completion of a Corrective Action Study. The first step of the project requires developing cleanup level action standards for use in the study area. These cleanup standards will be used to delineate areas requiring cleanup; and based on those areas Anchor will develop alternatives for the Corrective Action Study that include a combination of dredging, capping, and enhanced natural recovery. Concurrent with the Corrective Action Study, the PRP group is assessing their NRD liability, and to the extent that remedial measures can be integrated with restoration measures, our project team is working both regulatory issues in parallel.

Gasco MGP Site –Portland, Oregon

Mr. Schadt is the project manager for the investigation and remediation of sediments located in a river offshore from a former manufactured gas plant site. Key components of the project include evaluating the role of potential on-going groundwater sources versus historical releases to the river. Modeling of groundwater flow to the river sediments has been completed to demonstrate that existing contamination is the result of historical releases. Hot spot removal is being considered, in conjunction with capping, as mechanism to remediate PAH contamination present at the site. In addition to conducting an aquatic risk assessment for the sediment portion of the site, Anchor is also involved in components of the upland remediation including a terrestrial risk assessment to determine soil cleanup requirements, and the evaluation of future site-use scenarios that incorporate upland caps as part of the site redevelopment plans.

A discrete location within the site has been designated for a time critical removal action by EPA. Anchor is currently developing a remedial design document for the removal of a hot spot location. This action will be completed using mechanical dredging of the hot spot, and upland disposal of the sediments. Following completion of the time critical removal action, Anchor will then evaluate whether or not further remediation is necessary, and if so what remedies are most suitable to consider.

Vancouver Smelter Sediment Site – Columbia River, Washington

Mr. Schadt is the project manager for a PCB cleanup in sediments in the Columbia River in the vicinity of Vancouver, Washington. His role has included oversight of a screening level risk assessment to determine acceptable PCB cleanup levels; and he has directed a feasibility study evaluation to determine cost differences associated with the various cleanup levels. The feasibility study has included a sensitivity analysis that has demonstrated that 95 % of the mass of PCBs can be removed from the sediment at a cleanup threshold that is protective of the aquatic environment when area-weighted averaging is used for the home ranges of key species at the site. Dredging will likely be coupled with on-site disposal at an existing upland landfill.

Bellingham Bay Demonstration Pilot Project – Port of Bellingham, Bellingham, Washington.

Mr. Schadt led a demonstration project aimed at building a cooperative partnership to streamline cleanup of contaminated sediments in Bellingham Bay. The project brought together many government, industry, and Indian representatives who have a stake in the bay, and together prioritizes sediment remediation actions for the bay. Components of the project included locating suitable disposal sites, identifying high priority sediment sites to remediate, and integrating habitat restoration and land use objectives for the entire bay into the remediation strategy. The pilot project is the first of its kind in Puget Sound where a cooperative partnership process was used as the primary mechanism to develop and implement a cleanup project. A Comprehensive Strategy for cleanup in the bay was developed, and EIS was prepared on the Strategy, and components of the strategy have been implemented including contaminated sediment capping and habitat restoration.

Southwest Harbor Cleanup and Redevelopment Project – Port of Seattle, Washington.

Mr. Schadt managed the sediment task for this major site redevelopment project in Elliott Bay. Conducted under state Model Toxics Control Act authority, this project included characterizing the sediments that were adjacent to a former shipyard, and preparing a Feasibility Study that evaluated various cleanup alternatives. The Feasibility Study was the first sediment FS to be conducted under the MTCA guidelines. The preferred cleanup alternative included a combination of consolidation of contaminated sediments to a relatively small footprint, capping the consolidated area, and natural recovery of areas with levels of contamination which could justify recovery to acceptable levels in a reasonable timeframe.

Confined Disposal Standards, Department of Ecology, State of Washington.

Mr. Schadt managed a project that developed recommended standards for confined disposal of contaminated sediments for the State of Washington. The standards were developed for three distinct disposal environments: upland, nearshore, and confined aquatic. The standards included recommendations pertaining to characterization of contaminated sediments as it pertained to confined disposal, recommendations on siting considerations for locating disposal facilities, and design features for disposal facilities.

Terminal 91 Nearshore Fill – Port of Seattle, Seattle, Washington.

Mr. Schadt conducted the biological performance monitoring evaluation along the habitat component of a berm face at a nearshore confined disposal facility in Elliott Bay. The sampling targeted epibenthic organisms (juvenile salmonid prey items) that had recolonized the berm face. Comparisons of population size and diversity were made between the habitat along the berm and that of reference sites in Elliott Bay.

Simpson Tacoma Kraft Sediment Remediation.

Mr. Schadt served as project coordinator for one of the first contaminated sediment cleanups in Puget Sound. The site, located at a pulp mill in Commencement Bay, had contaminated sediments in the nearshore area due to the historical operation and discharge of the facility's outfall. The cleanup solution targeted leaving the materials in place to the greatest extent practicable, and using a cap confine the sediments and create habitat at the same time. A confining berm was placed at the deepest perimeter of the contaminated sediments, and an overlying cap was placed over the entire site using adjacent river delta silts and sands. The cleanup was constructed in 1986, and has been monitored annually since. The monitoring has verified successful confinement and no vertical migration of contaminants.

Asarco RI/FS – Commencement Bay, Washington.

Mr. Schadt served as project manager on this CERCLA site, completing an RI and FS for the offshore sediment component of the site. The Feasibility Study considered a Nearshore Fill option that provided deepwater berthing for future site use, a consolidated capping in place option that focused maximizing the amount of material left in place with an overlying cap designed to enhance intertidal habitat, and off-site deep water confined aquatic disposal option where sediments would be removed from the site and confined (capped at on off-site location). The feasibility included locating the most suitable site for each of the remedial options, and coordinating with design engineers to develop conceptual-level designs and cost estimates for use in the FS.

Lake Union Sediment Capping Feasibility Study – Seattle, Washington.

Mr. Schadt served as project manager on a feasibility study evaluating capping of contaminated sediments in a lake environment. Project elements included reviewing groundwater data from the upland facility (a former manufactured gas plant), reviewing sediment chemistry and biological data, and conducting a modeling exercise to determine the

probability of cap re-contamination due to groundwater flow and underlying contaminated sediments.

Missouri River / Omaha Smelter – Omaha, Nebraska.

Mr. Schadt is providing technical support to Asarco in responding to local government comments on the cleanup proposal at their lead smelter facility. Issues involved at the site include how the proposed upland remedy addresses the groundwater pathway from the site to the adjacent river, and the extent of contamination in the river's sediments. Mr. Schadt is responsible for reviewing site data, agency proposed sampling plans, and meeting with local government officials to discuss their comments on the proposed project. Sediment chemistry data collected from the site have been reviewed, and a screening level risk assessment completed to evaluate the effects of the current sediment conditions.

U.S. Navy Homeport, Everett Washington.

Mr. Schadt participated in numerous technical and environmental studies related to an environmental impact statement for the siting of a carrier battle group at Everett Washington. The project included the dredging and disposal of significant quantities of contaminated sediment. The preferred alternative was a deep-water confined aquatic disposal site. Technical issues associated with material dispersion became a central focus of the EIS, along with the disruption to aquatic resource habitat, particularly Dungeness crab.

Columbia Basin Studies, Washington and Oregon.

Mr. Schadt has participated in a variety of studies in the Columbia Basin, primarily assessing site development and operation impacts to salmonids. Projects have included water quality assessments and instream flow evaluations (water quantity) on juvenile salmonid passage, adult salmonid spawning habitat, and juvenile rearing habitat. Mr. Schadt worked for a number of Public Utility Districts, the Corps of Engineers, and a variety of Port Districts throughout the Columbia Basin.

JASON PAUL KASE
Environmental Scientist

EDUCATION
M.S., Biology, University of West Florida, 1999
B.S., Zoology, University of Florida, 1994

PROFESSIONAL CERTIFICATIONS
Radiation Safety Training, University of California
OSHA 40 Hour HAZWOPER training

PROFESSIONAL EXPERIENCE
Mr. Kase is a biologist with a strong emphasis in human health and ecological risk assessment, site management and characterization, coastal monitoring and restoration, and sediment quality and dredged material management. His expertise includes aquatic toxicology, marine microbiology, and molecular biology. Mr. Kase's experience includes conducting, supporting, and reviewing human health and ecological risk assessments for federal, state, and private clients through data management, statistical evaluation and interpretation of data, toxicity assessment, quantitative risk characterization, conceptual site model development, background assessments, and exposure modeling. He has extensive task management experience designing, conducting, and analyzing results of sediment and biota sampling programs in support of USEPA and USACE sediment quality and dredging programs; including support of NEPA related activities.

Mr. Kase was also an assistant project manager for a multimillion dollar engineering and design study to divert Mississippi River water to benefit coastal wetlands. His roles included Quality Manager in charge of coordinating, reviewing, and documenting all quality review of intermediate work products and deliverables. He was also the environmental task lead responsible for directly managing and delivering work related to dredge material management and disposal, wetlands value assessment, and coordinating with NEPA contractors.

REPRESENTATIVE PROJECT EXPERIENCE
Patrick Bayou Remedial Investigation/Feasibility Study (2005-current)

Mr. Kase serves as an environmental scientist/risk assessor for superfund site investigations of a tributary to the Houston Ship Channel that is surrounded by three major industrial manufacturing facilities. The project involves multiple potential contaminant phases and sources, and significant hydrodynamic concerns. Specific tasks involve development of site conceptual model, ecological and human health risk assessment, and development and implementation of remedial investigation and feasibility study workplans.

Bayou d'Inde Site, Calcasieu River and Estuary, Lake Charles, Louisiana (2005-current)

Mr. Kase works as an environmental scientist/risk assessor supporting feasibility and remedial design activities on behalf of a PRP group. Anchor is providing a wide range of project

management and technical services for the project, including further development of the site conceptual model, delineation of areas of interest, development of remediation goals and objectives, detailed risk assessment and NRD assistance.

Calcasieu Estuary Project, Lake Charles, Louisiana (2000 – 2005)

Mr. Kase was the task manager/risk assessor involved in preparing comments and consulting on strategy for a private client to address results of human health and ecological risk assessments for estuary-wide remedial investigation prepared by USEPA. He consulted on sediment management strategy for remediation alternatives for contaminated sediment. He was also a project team member on designing and conducting a recreational fish consumption survey to validate risk assessment assumptions within the estuary.

Ecological Risk Assessment; USACE, Garrows Bend, Alabama (2002 – 2003)

Mr. Kase was the task manager/risk assessor responsible for conducting an ecological risk assessment of potential dredged material for an environmental impact statement. He designed and executed field studies to identify the extent of contaminated sediment and to measure exposure and uptake by biological receptors. He also performed a baseline ecological risk assessment to evaluate restoration alternatives for the environmental impact statement.

Dredged Sediment Evaluation, USEPA, Bayou Lafourche, Louisiana (2002 – 2003)

Mr. Kase was the task manager/project scientist responsible for evaluating existing conditions, sampling and analysis design, field sampling, data analysis, and reporting to the client. The purpose of the project was to evaluate the suitability and potential risks of dredged material for various proposed disposal options.

Reintroduction of Mississippi River Water into Bayou Lafourche, Louisiana Dept of Natural Resources; Coastal Louisiana (2003 – 2005)

Mr. Kase was the task manager for long-term water quality monitoring including salinity, surface water elevation, and velocity in open channel flows in the Mississippi River Delta. In addition, he served as Assistant Project Manager for environmental tasks.

PUBLICATIONS

Jeffrey, WH, JP Kase, SW Wilhelm. Ultraviolet radiation effects on bacterioplankton and viruses in marine ecosystems. Demora, SJ, et al. Effects of UV radiation on marine ecosystems. Cambridge University Press, 2000.

Kase, JP, WH Jeffrey. Solar radiation effects on bacterial production in the Southern Ocean. American Geophysical Union Ocean Sciences Meeting, January 2000, San Antonio, TX.

Ahrens, S, WH Jeffrey, JP Kase, M Voytek. Changes in marine microbial community structure induced by solar radiation. American Geophysical Union Ocean Sciences Meeting. January 2000, San Antonio, TX.

Zhu, Y, K Mopper, WH Jeffrey, JP Kase, P Neale, R Davis. Effect of elevated levels of photochemically produced hydroxyl radicals and hydrogen peroxide on bacterial and primary productivities in Antarctic surface water. American Geophysical Union Ocean Sciences Meeting, January 2000, San Antonio, TX.

Peloquin, J, P Neale, WH Jeffrey, JP Kase. Spectral dependence of ultraviolet radiation on bacterioplankton: an experimental approach. American Geophysical Union Ocean Sciences Meeting, January 2000, San Antonio, TX.

Kase, JP, WH Jeffrey, S Ripp, JD Pakulski, DL Mitchell. DNA damage and inhibition of bacterial production due to UV in marine surface waters. American Society for Microbiology General Meeting, May, 1998, Atlanta, GA.

Kase, JP, M Burnett, AB Shortelle. Acute toxicity of low pH to the Brown Darter (Etheostoma edwinii) under flow-through conditions. Society of Environmental Toxicology and Chemistry 17th Annual Meeting, November, 1996, Washington DC.

DAN HENNESSY

Sediment Management/Risk Assessment

EDUCATION

M.S., Fisheries Science, 1998, University of Washington
B.S., Environmental Science, 1992, Western Washington University
B.A., Social Science, 1990, University of California at Irvine

PROFESSIONAL EXPERIENCE

Dan Hennessy is a sediment scientist/risk assessor with over twelve years of professional experience working on environmental projects at all levels, including project manager, aquatic toxicology laboratory manager, and field team leader. His work experience has included aquatic and terrestrial ecological risk assessment, human health risk assessment, sediment and water quality assessment and criteria development, biological monitoring, habitat analysis, natural resource damage assessment, and discharge permit evaluation.

REPRESENTATIVE PROJECT EXPERIENCE

Remedial Investigation/Feasibility Study of Former Scott Paper Mill Site, Anacortes, Washington

Co project manager for a comprehensive cleanup project at a former paper mill site requiring the assessment of localized upland and sediment contamination. Work products have included the compilation and review of existing data, development and refinement of the conceptual site model, evaluation of contaminant fate and transport, and a preliminary assessment of ecological and human health risks. Supplemental sampling to characterize the nature and extent of contamination in soils, groundwater, shoreline seeps, and sediment was recently performed and completion of the RI/FS is expected in late 2006.

Evaluation of Wood Debris Impacted Sediments, Port Gamble, Washington

Anchor is providing strategic and technical support for the cleanup of wood debris impacted sediments. Currently we are designing a study to evaluate the potential for natural recovery of the benthic community in sediments impacted by wood debris. Mr. Hennessy is the task manager responsible for evaluation of existing data, study design development, data quality assurance, data analysis and interpretation, and reporting.

Remedial Investigation/Feasibility Study of Former Creosote Manufacturing Site, Renton, Washington

Anchor is providing strategic and technical support for a comprehensive cleanup project at a former creosote manufacturing site requiring the assessment hydrocarbon-related contaminants in soils, groundwater, and lake sediment and surface water and wood debris in sediment. Mr. Hennessy is the task manager responsible for data quality assurance, data analysis and interpretation, ecological and human health risk assessments, and reporting.

MICHELLE MCCLELLAND
Database Manager / Environmental Chemist

EDUCATION

Bachelor of Science in Chemistry, University of Redlands, California, 1989.
OSHA 40-Hour Hazardous Waste
OSHA 8-Hour Site Supervisor
American Chemical Society member (ACS)

PROFESSIONAL EXPERIENCE

Michelle is an environmental chemist with over 12 years consulting experience, specializing in coordination of sample and analytical chemistry data, managing databases, preparing sampling and analysis plans and data reports, and coordinating field sampling programs. Additional responsibilities include: writing and reviewing Sampling and Analysis Plans, Quality Assurance Project Plans, and Data Reports; coordinating with GIS personnel to improve the efficiency of data mapping; and preparing electronic deliverables for delivery to a variety of data management systems.

REPRESENTATIVE PROJECT EXPERIENCE

Quality Control and Data Management, Kimberly-Clark, Washington
Responsibilities included converting data from a legacy database system for import into an MS Access database, preparing data for statistical analysis, creating summaries of data for import into ArcGIS, and report preparation.

Quality Control and Data Management, Boeing Auburn, Washington
Responsibilities included providing technical guidance for development of the Quality Assurance Project Plan and the Sampling and Analysis plan, coordinating field activities, laboratory coordination, data management and interpretation, and report preparation.

Field Sample Tracking Database, USACE, Seattle, Washington
Designed and built a database for use on site during a large site investigation. The database was programmed in MS Access for use in the field and allowed manual or electronic data entry of locations, samples and analytical methods. Users were able to print daily location and sample reports, as well as track samples through the analytical laboratory process.

Document Tracking Database, Lower Willamette Group Feasibility Study, Oregon
Created a database to track environmental reports, documents and communications for a long-term project along the Willamette River in Oregon. Also responsible for coordinating the activities of data entry and other data management personnel; communicating with project managers and outside clients to meet the project needs.

DENNIS HANZLICK, PH.D.

Sediment Characterization

EDUCATION

Ph.D., Physical Oceanography University of Washington, 1983
M.S., Physical Oceanography University of Washington, 1976
B.S., Engineering Physics University of Kansas, 1968
Level C Protection Certified (OSHA 29 CFR 1910)

PROFESSIONAL EXPERIENCE

Dr. Hanzlick has expanded his technical background in physical oceanographic processes in nearshore and open-ocean settings to encompass investigation and evaluation of marine sediments, application of numerical models to environmental problems, investigation and remediation of contaminated marine and terrestrial environments, and oversight of health and safety programs for field operations. He is skilled in the planning, management, and execution of many types of field sampling activities.

Dr. Hanzlick was deputy program manager for a major sediment analysis program and field operations leader for several sediment characterization programs. He continues to be involved with the maintenance dredging program for a major west coast port and has designed the water quality monitoring program to support construction of new berths. He has managed two remediation projects, one involving several contaminated locations at a National Priorities List site and another involving a barge filled with contaminated materials.

Dr. Hanzlick used numerical models to predict water quality impacts resulting from dredging operations and disposal of dredged materials, and storm-surge conditions for a connected river/canal/harbor system in New Jersey. He applied computer models to examine the speciation of metals in mine effluent and holding pond scenarios, to predict the transport and fate of contaminants in a river estuary system, and to estimate mixing zone dimensions for discharges. For NOAA, he has reviewed and commented on several reports concerning modeling approaches proposed or used for projects related to hazardous waste sites.

Dr. Hanzlick's capabilities for supporting various types of projects include providing mathematical review of quantitative approaches and results, consulting on the design of field programs, preparing sampling and analysis plans, preparing and administering health and safety plans for field projects, and writing and reviewing project reports or report sections.

REPRESENTATIVE PROJECT EXPERIENCE

Sediment Sampling and Analysis in Various Northwest States, Seattle, Washington

Managed a Corps of Engineers IDIQ Contract for which 18 task orders were awarded. Five included sediment characterization projects requiring vibracoring or surface grab sampling. Others included diver-performed eelgrass surveys and pre- and post-construction beach profile surveys. Total awarded was approximately $600,000.

Sediment Characterization for Port of Seattle Fishermen's Terminal, Seattle, Washington

Designed, wrote the plans, and directed fieldwork for conducting sediment characterization for navigation dredging at Fishermen's Terminal. Approximate cost was $100,000.

Port of Longview Berth 9 Construction, Longview, Washington

Designed a sampling scheme and wrote the plans for sediment characterization to be conducted from a barge-mounted drill rig. Characterization was in connection with dredging to be conducted as part of the Berth 9 construction project. Approximate cost was $10,000.

East Waterway Operable Unit – Phase 1 Removal Action, Seattle, Washington

Designed and assisted in the implementation of a water quality monitoring plan for investigation of water quality during dredging operations. Worked closely with EPA to develop the water quality certification. Approximate cost for design and plans was $16,000.

Port of Seattle T-18 Stage 1A Sediment Investigation, Seattle, Washington

Designed, wrote the plans, and directed fieldwork for a sediment characterization project involving collection of sediment samples and submitting them for chemical, bioassay, and bioaccumulation analysis. Approximate cost was $60,000.

JOHN R. VERDUIN III, P.E.
Senior Geotechnical Engineer

EDUCATION
M.S. Engineering, 1988, Purdue University
B.S. Geological Engineering, 1986, Magna Cum Laude, University of Missouri-Rolla

PROFESSIONAL REGISTRATION AND MEMBERSHIP
Professional Engineer, States of California, Florida, Louisiana, Michigan, Minnesota, Mississippi, New Hampshire, New York, Ohio, Oregon, Texas, Washington, and Wisconsin
Professional Geotechnical Engineer, State of California
Member, Western Dredging Association
American Society of Civil Engineers

PROFESSIONAL EXPERIENCE
Mr. Verduin has over 17 years of experience applying innovative engineering approaches to port, harbor, and waterway projects throughout the United States. As a senior engineer at Anchor Environmental, he is responsible for completing geotechnical engineering studies, analyzing contaminant transport mechanisms, managing structural and hydrographic waterway surveys, developing and evaluating remedial engineering approaches and cost estimates, and designing and implementing remedial actions, including preparation of plans, specifications, support documentation, and construction oversight. Mr. Verduin is uniquely qualified to evaluate the full range of potential contaminated sediment remedial alternatives, being one of the few engineers in the country to actually design and see implemented (during construction) many of the different available remedial alternatives. He has designed remedial alternatives involving natural recovery, enhanced natural recovery, *in situ* capping, mechanical and hydraulic dredging, confined disposal, and treatment. Mr. Verduin's strong background in geotechnical/civil engineering also allows him to integrate aspects of the potential remedial solution into future development needs.

REPRESENTATIVE PROJECT EXPERIENCE
Gasco Early Action Remediation--Willamette River, Portland, Oregon (2003-ongoing)

Anchor is leading a remedial investigation of the Northwest Natural "Gasco" site on the Willamette River in Portland, Oregon. The site, a former coal gasification facility, is impacted with metals and carcinogenic PAHs in the soils and groundwater. John Verduin served as the senior engineer during design and construction implementation. Anchor designed and managed the implementation of a time-critical Superfund Removal Action to address a tar deposit on sediments in the Willamette River in Portland, Oregon. The site is a former oil-gasification plant and byproducts refinery that operated between 1913 and 1956. During part of the period of operations, wastewater effluent and tar-stills were disposed of in settling ponds on a portion of the facility. The ponds were closed in the 1970s but previously some of the tar was released from the ponds and deposited on the river bank and shallow sediment. The removal

action involved dredging surface tar from the river adjacent to the site and disposing of the tar off-site at an upland landfill. A pilot subaqueous cap was installed over a portion of the removal area. Anchor studies of the affected area to characterize the site for design of the Removal Action and complete the preliminary design. Anchor assisted in the selection of a contractor to perform the removal action and worked with the contractor to complete the final design for approval by the U.S. Environmental Protection Agency. During implementation, Anchor monitored activities—including dredging, transportation, and installation of cover—for compliance with the design and environmental-protection requirements. Anchor also collected water samples to monitor compliance with environmental-protection requirements and document that the Removal Action was performed in accord with the design.

Onondaga Lake Feasibility Study, Syracuse, New York (2003-ongoing).

Anchor is assisting Honeywell is preparing the Feasibility Study for Onondaga Lake. Onondaga Lake is an urban lake located in Syracuse and is roughly 4 square miles in size. Millions of cubic yards of sediment have been impacted by past industrial activities at and around the lake. Contaminants of concern include mercury from a former chlor-alkali plant, multiple organic contaminants, and Solvay waste. NAPLs have been identified in some locations of the lake. Impacted sediments have very unique physical characteristics affecting the evaluation and design of remedial measures. Mr. Verduin managed and directed the technical studies for the FS. The extensive technical studies completed included development of sediment and fish tissue remedial goals, detailed evaluations of capping, dredging, upland disposal, natural recovery, and aeration and integration of habitat restoration into lake-wide cleanup. He contributed significantly to the dredging, disposal, and capping technical studies. He provided senior review of the FS as well. Mr. Verduin also provided strategy during FS development and participated in multi-agency presentations and discussions.

Lower Fox River and Green Bay Remedial Cleanup Design, Fort James Operating Company and NCR, Green Bay, WI (2004-ongoing)

Anchor is currently conducting remedial design studies for the cleanup of Operable Units (OU) 2 through 5 of the 39-mile-long river Lower Fox River and Green Bay. The study area begins just upstream of the Little Rapids Dam (OU 2) and continues approximately 13 miles through OUs 3 and 4 into Green Bay (OU 5). With approximately 11.6 million cubic yards of PCB-contaminated sediments identified by the ROD, 6.5 million cubic yards of which are targeted for dredging and upland disposal, the Lower Fox River has been identified as the single largest contaminated sediment cleanup site in the U.S. The final remedy for the river could include capping of over 500 acres of the river bottom, again one of the largest capping projects in the U.S. Mr. Verduin is involved in all aspects of the remedial design. He is leading the cap design effort, evaluating issues such as contaminant transport through the cap, river current erosion, ice scour, slope stability and bearing stability on the soft sediments. He is also assisting with dredge and disposal design for the ROD remedy including detailed cost estimates.

Peer Review of Engineering Performance Standards, Hudson River PCBs Superfund Site, New York (2003-2004)

Mr. Verduin was retained to provide an independent technical peer review of the Engineering Performance Standards developed by EPA for the Hudson River PCBs Superfund site. The three standards are to be used to monitor the 2.6 million cubic yards of remedial dredging to be complete on the Hudson River. The Resuspension Standard was developed with a water quality monitoring plan and three tiered action levels leading up to a maximum allowable concentration of PCBs in river water. The Dredging Residuals Standard was developed to monitor post-dredge surface concentrations and determine the plan of action to address residual concentrations if identified. The Productivity Standard was developed to ensure completion of the remedial action within 6 years. This standard required compliance with minimum cumulative volumes of sediment dredging each year. Mr. Verduin attended two public meetings, reviewed existing data, and prepared conclusions and recommendations on the three standards. He helped author the final recommendations paper.

Dredging Pilot Study, Lavaca Bay Sediment Remediation Project, Point Comfort, Texas (1998-ongoing).

Mr. Verduin was the project engineer for a dredging treatibility study. The first phase of the treatability study removed 70,000 CY of contaminated sediment using a 20-inch hydraulic cutterhead dredge. The material was disposed at an upland CDF. Water depth varied from 8 to 30 feet. The material being dredged was a fine-grained plastic sediment. The second phase of the study utilize a 12-inch hydraulic dredge removing 10,000 CY of contaminated sediment in one to five feet of water. For both projects water quality impacts were monitored as well as residual sediment concentrations left after dredging. The dredging approach was varied to monitor the affects on water quality and dredging residuals. Variations included cutterhead rotation, arm swing speed, advance rate, and cut depths.

Los Angeles County Dredged Material Management Plan Pilot Studies, Los Angeles District Corps of Engineers (COE): Los Angeles, California (2001-ongoing).

Anchor is assisting the COE in implementing four remediation alternative pilot/bench scale studies to evaluate the technologies for use in a regional Dredged Material Management Plan for the Los Angeles and Long Beach area. The four remediation/disposal alternatives include: aquatic capping, cement-based stabilization, sediment washing for chloride removal, and sediment blending. Mr. Verduin was the project engineer for the aquatic capping pilot study. Technical tasks being performed by Anchor include: preparation of sampling and analysis plans, short-term and long-term monitoring plans, modeling studies for contaminant mobility and sediment transport, oversight of sediment characterization efforts (i.e., chemical, contaminant mobility, physical and geotechnical testing), workplans for the treatability bench scale studies, engineering design, bid plans and specifications, construction management, monitoring oversight, and preparation of Evaluation Reports for each remedial alternative. Anchor is also assisting the COE in permitting activities and regulatory coordination including:

preparation of the NEPA Environmental Assessment, Coastal Commission Consistency Determination, and COE 404(b)1 analysis.

Port of Seattle East Waterway Deepening Project, Seattle, Washington (1998-2000).

Mr. Verduin was the project engineer during dredging of the East Waterway. Anchor, working for the Port of Seattle and the U.S. Army Corps of Engineers completed the design and assisted the Corps in the preparation of the construction documents for this complex marine project. The project involved the dredging and open water disposal of 140,000 CY of clean navigational material as well as the dredging and upland disposal of 80,000 CY of contaminated sediment. The contaminated sediment was mechanically dredged using environmental buckets and standard clamshell buckets. The material was then offloaded where it was treated with a lime additive. Surface water was captured and treated before discharging. A pilot study was completed prior to construction to evaluate the effectiveness of using environmental buckets. The conclusion of the study that environmental buckets would have limited success in the East Waterway was confirmed during construction.

Lake Okeechobee Pilot Dredging Study, West Palm Beach, Florida (2000-ongoing).

Mr. Verduin is the project engineer assisting with dredging and disposal design on the Lake Okeechobee Pilot Dredging Study. Lake Okeechobee has over 200,000,000 CY of nutrient impacted sediment. The average thickness of the very soft fine-grained sediment is 3 to 6 inches. The Dredging Pilot Dredging Study will evaluate the effectiveness of dredging the lake sediments. The project team will design a dredge to remove roughly 10,000 CY of sediment.

Whatcom Waterway Log Pond Capping, Bellingham, Washington (1996-ongoing).

Mr. Verduin was the project engineer during the design and construction of an *in situ* cap to confine contaminated sediments. The mercury contaminated sediments were capped in place with clean navigational dredge material. Cap design assessed contaminant transport, cap erosion, and seismic issues. The 40,000 CY of capping material was placed with a mechanical bucket slowly in thin lifts.

Sediment Corrective Measure Action, Barberton, Ohio (2001-ongoing).

Mr. Verduin was the project manager and engineer designing an in situ cap for sediments impacted with hexachlorobenzene and metals. The sediments were very soft organic silts ranging in thickness from 2 to 10 feet. Anchor completed a field program to determine the strength and compressibility of the soft sediments as well as the porewater quality. Anchor used this data to determine the appropriate means to cap the sediments as well as assess the long-term water quality impacts associated with the design. Anchor provided construction support services to the client during the capping operation. The project was completed on budget at a cost of roughly 10 percent of the removal alternative proposed by another consultant.

St. Louis River/Interlake Duluth Tar Site, Duluth, Minnesota (1998-ongoing).

Mr. Verduin is assisted Interlake in completing a feasibility study at this former Manufactured Gas Plant (MGP) Superfund Site on the St. Louis River in Duluth Harbor. For the FS he coordinated physical testing of the sediments to assess the potential of capping the sediments in place as well as settling and compressibility characteristics of the dredged material. Anchor used this data as well as other information to evaluate two remedial options: 1) *in situ* capping of contaminated sediments; and 2) removal and disposal of contaminated sediments at different potential confined disposal facilities (CDFs) including contained aquatic disposal (CAD) and nearshore fills. Because of shallow water depths and the nature of the contaminants (PAHs), Anchor also evaluated different types of construction equipment to remove and cap sediments. Anchor is now assisting the client in developing construction documents for implementation of the remedial measure.

Commencement Bay Nearshore/Tideflats Superfund Site - Thea Foss and Wheeler-Osgood Waterways Pre-Remedial Design, City of Tacoma, Tacoma, Washington (1994-1998).

Mr. Verduin was project engineer for the sediment remedial design component of this large-scale waterway redevelopment. Technical elements of the remedial design included an evaluation of source control measures, a natural recovery analysis, sediment chemistry fate and transport, an evaluation of potential disposal sites, a hydrographic survey, and the development of habitat mitigation plans. The remediation concept includes natural recovery in the mouth of the waterway, enhanced natural recovery in its middle section, and more active remediation at the head of the waterway. Several alternatives are under consideration for the active remediation, including capping the contaminated sediments in place or removing them to a confined aquatic, nearshore, or upland disposal site.

Irvine Lake Desilting Project Evaluation, Irvine Ranch Water District (1999-2000).

Anchor was asked by the Irvine Ranch Water District (IRWD) to perform a dredging operations audit of their Contractor. This project is an 11 year project which involves dredging over 13 million cubic yards of material to restore reservoir capacity and to provide a revenue source from aggregate sales. The project was in its third year and the Contractor has requested a five year extension due to low production rates. Anchor provided review and assessment of the equipment and operations, and worked with IRWD and the Contractor to develop alternative approaches to get the project back on schedule.

Sediment Corrective Measure Action, Lake Charles, Louisiana (2001-ongoing).

Mr. Verduin is the project engineer evaluating remedial alternatives to address hexachlorobenzene, hexachlorobutadiene and metals impacted sediments in a canal system. Remedial measures being investigated include natural recovery, in situ capping, removal, and subaqueous disposal. Anchor completed a field sampling program to support the engineering analyses for the different alternatives.

Harbor Island Sediments Superfund Site, Lockheed-Martin, Seattle, Washington (1994-1998).

Mr. Verduin performed a preliminary assessment of remedial alternatives, including an analysis of potential cap thicknesses, dredging techniques, disposal locations, and estimated

costs. By better defining the extent and depth of sediments requiring remediation and focusing the effort on the most cost-effective option for meeting the state's Sediment Management Standards, the design team sought to reduce reliance on higher-cost options detailed in the EPA's remedial investigation/feasibility study. The design team also reviewed EPA documents, including the EPA's proposed remedial plan, for technical merit and feasibility.

Whatcom Waterway Site RI/FS, Bellingham, Washington (1995-ongoing).

Mr. Verduin was the project engineer and feasibility study manager for this state Superfund site. The facility's chlor/alkali plant discharged wastewaters containing mercury to the Whatcom Waterway for roughly 10 years. Remedial alternatives being considered to address the roughly 1,600,000 CY of impacted sediment include natural recovery, enhanced natural recovery, *in situ* capping, dredging and confined disposal. He was the lead engineer assessing the different means of disposing the contaminated sediments, including nearshore and aquatic disposal. He also oversaw physical and chemical mobility testing of sediments within the waterway as part of the remedial investigation as well as in support of the feasibility study.

Newburgh Lake Restoration, Rouge River, Livonia, Michigan (1996-1997).

Mr. Verduin served as senior engineer for the design team's efforts to restore this 105-acre impoundment. The restoration includes the rehabilitation of the dam that creates the impoundment, the dewatering of the lake, and the subsequent removal of 600,000 cubic yards of sediments, some of which are contaminated with up to 50 parts per million of PCBs. Mr. Verduin also participated in an engineering review of the plans and specifications for the project to ensure that these documents and project activities represent the state of the art for sediment remediation.

Cargill Salt Pond Remediation, San Francisco Public Utilities Commission: Menlo Park, California.

Anchor was a subconsultant to Camp Dresser & McKee, providing dredging and sediment management expertise to the City and County of San Francisco in support of this State Cleanup Site. Portions of the salt pond historically were used as a skeet shooting range, and there are high concentrations of lead present in the soil and sediment requiring removal and disposal. Treatability studies for stabilization and separation of the lead have been conducted by CDM and results were used by Anchor in developing conceptual remediation alternatives. Mr. Verduin provided technical review for the project. Anchor provided analyses of various removal and disposal processes, including: mechanical dredging, hydraulic dredging, and excavation in a dewatered pond. Construction components and durations, estimated costs, and evaluation of potential water quality impacts were addressed in the alternatives evaluation report.

Eagle Harbor West Operable Unit Sediment Remediation, Bainbridge Island, Washington (1994-ongoing).

Mr. Verduin served as the project engineer responsible for developing design documents for sediment remediation, including a remedial analysis design report, plans and specifications, a

construction quality assurance plan, an operations, maintenance, and monitoring plan, a cost estimate and schedule for construction, and a permitting and site access plan. Mr. Verduin also determined the feasibility of a nearshore fill to contain and confine contaminated sediments, while creating usable upland for the client. Through this careful, detailed design work and a thorough analysis of remedial options including natural recovery, enhanced natural recovery, cement stabilization, excavation and upland disposal, and thick capping, the design team was able to reduce the area of removal and increase the area deemed suitable for natural recovery and thin-layer capping. The remedial action was completed in October 1997. Mr. Verduin assisted the client in procuring a contractor, provided construction support services during construction, and will assist in providing services for the long-term monitoring of the site. The project was implemented on schedule and within budget.

Sitcum Waterway Remediation Project, Port of Tacoma, Tacoma, Washington (1991-1995).

Mr. Verduin contributed to several phases of the Sitcum Waterway Remediation. This Superfund project involved the dredging and disposal of 2.5 million cubic yards of sediment while at the same time supporting the Port's long-term development needs. As task manager for geotechnical aspects of the pre-remedial design and related natural resources data collection, he was responsible for all geotechnical engineering, including the dredge characteristics of sediments, the stability of existing offshore slopes, an underwater survey of existing slopes, and the determination of dredge limits. In the pre-remedial evaluation report, Mr. Verduin screened the suitability of numerous sites for the confined aquatic disposal, nearshore disposal, or upland disposal of dredged sediments. He also served as task manager during the development of remedial plans and specifications and provided construction consultation during the remedial action.

PUBLICATIONS AND PRESENTATIONS ON WATERFRONT AND SEDIMENT TOPICS

Verduin, J. and Bill Lynch. "Capping Very Low Strength Hexachlorobenzene-Impacted Sediments: A Case Study" 3rd International Conference on Remediation of Contaminated Sediments. New Orleans, LA January 2005.

Verduin, J. Session Moderator: In Situ Sediment Capping. 3rd International Conference on Remediation of Contaminated Sediments. New Orleans, LA January 2005.

Verduin, J. and Jim Hahnenberg. "Ebb and Flow of Dredging: An Overview". Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites. USACE/USEPA/SMWG Joint Sediment Conference. St. Louis, Missouri. October 2004

Verduin, J. "Successfully Capping Soft Sediments." EPRI Capping Workshop sponsored by USEPA, USACE, and NOAA. Cincinnati, Ohio. May 2003

Verduin, J., Fields, J., Wang, T., Guannel, G., McCauley, M., Poon, Y., Chang, M. (2002) "Los Angeles Region Dredged Material Management – Design and Construction of the Aquatic

Capping Pilot Project." Third Specialty Conference on Dredging and Dredged Material Disposal. Orlando, Florida. May 2002.

Hilarides, C., Magruder, K., Patmont, C., and **Verduin, J.** (2002) "Implementation and Monitoring of a Combined Sediment Capping and Habitat Restoration Project at a Mercury Contaminated Sediment Site." Third Specialty Conference on Dredging and Dredged Material Disposal. Orlando, Florida. May 2002.

Verduin, J., Hilarides, C., Langdon, B., and Patmont, C. (2001) "Productive Reuse of Dredged Material." Proceedings 21st Annual Meeting and Technical Conference of the Western Dredging Association. Houston, Texas. June, 2001.

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Verduin, J.R., Mark Valentine, Clay Patmont, John Lally, Steve Liikala, Rod Gowdy, Mike Whelan, Rick Singer. "Eagle Harbor West Harbor Operable Unit Case Study The Successful Implementation Of A Contaminated Sediment Remedial Action." World Dredging Congress. June 28-July 2, 1998.

Verduin, J.R. Instructor "In-Situ Capping of Contaminated Sediments—A Seminar for Decision Makers" November 20-21, 1996, Chicago, Illinois.

Verduin, J.R., P.A. Spadaro, and T. Wang. "A General Framework for Consideration of a Nearshore Fill: Contaminated Sediment Confinement and Upland Creation." Western Dredging Association, Pacific Chapter Meeting. October 1995.

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Verduin, J.R., D. Saathoff, and G.E. Horvitz. "Port of Tacoma Milwaukee Waterway Nearshore Fill Design." Second International Conference on Dredging and Dredged Material Placement, Dredging '94. November 1994.

Verduin, J.R., G.E. Horvitz, and R. C. Gilmur. "Evaluation of Remedial Options for the Sitcum Waterway Sediments: A Case Study." Second International Conference on Dredging and Dredged Material Placement, Dredging '94. November 1994.

THOMAS S. WANG, P.E.
Partner

EDUCATION
B.S. Civil Engineering, University of Washington 1990

PROFESSIONAL REGISTRATION AND HONORS
Registered Professional Civil Engineer (Washington)
Hazardous Waste Operations and Emergency Response certified
Director, Western Dredging Association (WEDA) National Board
WEDA 2004 Dredger of the Year Award
U.S. Co-Representative to PIANC (Dredging Best Management Practices Committee)
Round Table Group Scholar

PROFESSIONAL EXPERIENCE
Mr. Wang has over fifteen years of experience managing and designing a diverse range of marine dependent projects, both in the United States and internationally, from the initial planning and permitting stages through design and construction. Mr. Wang is a nationally recognized dredging expert, and was selected as the Western Dredging Association's 2004 *"Dredger of the Year."* He has successfully completed over 200 sediment management projects, each involving dredging, permitting, characterization, design and construction support. In addition, Mr. Wang has extensive experience with Port facilities and Port operations. Multiple clients, including Ports of Seattle, Tacoma, Oakland, San Francisco, and San Diego have on-call contracts with Anchor where Mr. Wang provides dredging and sediment management consulting services.

Mr. Wang has extensive experience in managing and coordinating multidisciplinary teams and working with resource agencies and the public. He currently manages and designs projects throughout the United States in various disciplines including dredging, sediment management and remediation, port development, habitat restoration, hydraulic engineering, and marine construction management.

REPRESENTATIVE PROJECT EXPERIENCE

On-Call Coastal Planning Contract, USACE, Los Angeles District: Los Angeles, California.

Mr. Wang was the program manager for this five-year on-call contract. Work conducted has included dredging design and PS&E, development of a dredged material management program, permitting and BA preparation, marine construction management, sediment characterization, long-term benthic and sediment quality monitoring, water quality studies, coastal engineering and shoreline processes studies.

East Waterway Deepening and CERCLA Remediation, Port of Seattle: Seattle, Washington.

Mr. Wang was the Port's internal project manager for Stage 1 design conducted under the Corps' 404 permit, and was the designer of record. Mr. Wang is the project manager for the on-going East Waterway remediation project, conducted under EPA CERCLA authority. Key tasks included dredging and disposal, geotechnical evaluation, sediment characterization, permitting, sheetpile wall installation for slope stabilization, bathymetric surveying, design, bid documents, and construction support services.

Port of San Francisco Maintenance Dredging On-Call Contracts Revision, Port of San Francisco: San Francisco, California.

The Port of San Francisco asked Mr. Wang to conduct dredging contracting short courses, and to review and revise the Port's existing on-call maintenance dredging bid documents. Mr. Wang continues to provide on-call dredging and sediment management services to the Port.

Campbell Shipyard Remediation, Port of San Diego: San Diego.

Mr. Wang is the project manager for this State cleanup project (conducted under a Cleanup and Abatement Order). This project includes dredging, capping, seawall repair and replacement, mole pier retrofit, propwash erosion protection, habitat mitigation, sheetpile wall breakwater, navigation aids, and shipway demolition.

Larkspur Ferry Terminal Berth and Channel Maintenance Dredging, Golden Gate Bridge Highway and Transportation District: Larkspur, California.

Mr. Wang was the Partner-In-Charge and engineering lead for dredging design and construction support services for this berth maintenance dredging project. Currently, he is filling the same roles for the entrance channel project. Project components include permitting, sediment characterization, design and bid documents, bid assistance, and construction support.

Cargo, Piers and Industrial Properties (CPIP) Management, Port of Seattle: Seattle, Washington.

The Port requested Mr. Wang to act as its internal project manager for the CPIP line of business. Representative projects managed during his tenure included: T-91 Berths EFG construction; design for T-91 Berths 1/3/5/7; T-115 repaving; T-30 riprap evaluation; King County utility corridor relocation; and Y2K facility testing and upgrades.

Port of Vancouver Berth Deepening, Port of Vancouver: Vancouver, Washington.

Mr. Wang is the partner-in-charge of the Port of Vancouver's berth deepening project. Approximately two miles of existing riverfront facilities will be deepened to meet the USACE authorized channel depth within the upper Columbia River. Structural and slope stability, and Port tenant operations are critical aspects of this project.

Terminal 46 Berth Dredging and Structural Assessment, Port of Seattle: Seattle, Washington.

Mr. Wang was the project manager for this fast track dredging project conducted for the Port of Seattle to provide -50 ft MLLW berthing depth at the terminal. This project includes dredging

and disposal design, sediment characterization, permitting and BA preparation, structural and geotechnical impacts assessment, construction oversight, and water quality monitoring. Anchor met the Port's fast-track schedule and completed all work in less than one year.

Sitcum Waterway Superfund Remediation Project, Port of Tacoma: Tacoma, Washington.

Mr. Wang was the project engineer responsible for the remedial design and bid document preparation. Design elements included hydraulic and mechanical dredging, sediment characterization, confined disposal facilities, and habitat restoration. This project won the *1998 Consulting Engineers Council of Washington Engineering Excellence Grand Award* and *1998 American Consulting Engineers Council Engineering Excellence Honor Award.*

On-Call Sampling Contract, USACE, Multiple Districts: Seattle, Portland, Los Angeles

Mr. Wang was the program manager for several IDIQ contracts with the USACE. Work conducted under these contracts has included numerous sediment characterizations for dredged material, biological studies, capping monitoring, water quality monitoring, and benthic monitoring.

SHAWN M. HINZ, MS
Environmental Toxicologist

EDUCATION
M.S. Environmental Science/ Marine and Estuarine Science, WWU, 1999
B.S. Biology, Whitworth College, 1998

PROFESSIONAL EXPERIENCE
Mr. Hinz is an environmental risk assessor with more than nine years of experience in the environmental sciences. He has participated in most phases of environmental project work, including sampling design and collection, data analysis and interpretation, risk assessment, and subsequent site clean-up. Mr. Hinz has filled many roles on environmental projects including project manager, technical lead, quality assurance/quality control officer, database administrator, and field team leader. He is experienced and effective both in planning and implementing highly technical projects, and dealing with associated strategy and policy.

Mr. Hinz has extensive experience in assessing aquatic and upland systems, with particular emphasis on contaminated sediment sites. He has performed numerous aquatic and terrestrial remedial investigations at hazardous waste sites with multiple contaminants, for both industrial and government clients. Many of these investigations have included detailed human health and ecological risk assessments and subsequent site-specific remedies. Mr. Hinz has extensive knowledge of State and Federal regulations and has helped clients comply with relevant requirements.

Mr. Hinz has implemented many field studies and has expertise with the techniques for collecting sediment, soil, water, and biological samples. He has extensive technical writing experience and is skilled at presenting technical concepts to both scientific and general audiences. He is skilled in laboratory procedures, including comprehensive experience with laboratory instruments, protocols, and QA/QC practices.

REPRESENTATIVE PROJECT EXPERIENCE
Portland Harbor Superfund Site Ecological Risk Assessment

As a risk assessor, Mr. Hinz provided technical and strategic support for addressing groundwater and sediment impacts on aquatic and terrestrial risk. The ecological risk assessment addressed a diverse array of contaminants and their potential impacts on resident and migrating species, including ESA-listed salmonids. Mr. Hinz represented a multi-party client group which worked cooperatively with the EPA on approach and implementation of the assessment.

Lower Duwamish River Superfund Site RI/FS

As a toxicologist Mr. Hinz was involved in data collection and analysis for a large-scale environmental risk assessment of the Lower Duwamish Waterway. The investigation identified

candidate sites for early action under non-time critical removal authority and identified critical data requirements for completing the baseline risk assessment.

East Waterway Site RI/FS

Mr. Hinz served as the interim project manager for the East Waterway, located within the Harbor Island Superfund site near Seattle, Washington. The investigation of sediment contamination at the site lead to a series of interim remedial activities. Non time critical sediment remediation required under CERCLA was strategically coordinated with navigation dredging.

Southern California RI/FS Risk Assessment

Mr. Hinz provided consulting on subsurface investigations, spatial analysis, application of risk scenarios and RI report preparation at nine former manufactured gas plant investigations located in Southern California.

PAH Contaminant Bioavailability Study

Mr. Hinz worked as a risk assessor and bio-statistician with a national consortium of scientist evaluating protocols for measuring polynuclear aromatic hydrocarbon (PAH) bioavailability. The research focused on the development of a tiered assessment for calculating risk associated with site-specific contaminants at upland manufactured gas plant sites.

Gas Works Park, Sediment Investigation and Upland Remediation

Mr. Hinz served as a technical advisor and a field manager for the sediment investigations and upland remedial activities that occurred at Gas Works Park after 2000 (RETEC). This work was done with a former employer.

King County Strategic Initiative- Salmon Planning

Technical advisor for the King County Watershed Strategic Assessment Initiative. Mr. Hinz is supporting salmon recovery planning efforts for King County. Currently, Mr. Hinz is coordinating the development of a predicative model to identify viable population levels for salmon.

Terrestrial Ecological Risk Assessment at a Manufactured Gas Plant, Portland, Oregon

Conducted a terrestrial ecological risk assessment to evaluate potential impacts to invertebrates birds, and mammals as part of the cleanup requirements at a former manufactured gas plant. The work applied the risk assessment requirements of the Oregon Division of Environment Quality and utilized food-chain modeling to estimate exposure and probabilistic methods to address uncertainty. The assessment will be used as a baseline on which to evaluate cleanup alternatives at the site.

Bayou d'Inde Group RI/FS

Currently providing strategic and technical support to the Bayou d'Inde Group in its ongoing efforts to develop a management approach within this AOC in the Calcasieu Estuary. Efforts to-date have focused on the development of a comprehensive risk management strategy.

Future efforts will include the evaluation of Corrective Action alternatives and the integration of restoration approaches as part of a comprehensive remedy that includes resolution of any NRDA-related issues.

C. KIRK ZIEGLER, Ph.D., P.E.

CONTACT INFORMATION

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PROFESSIONAL HISTORY

Quantitative Environmental Analysis, LLC, Vice President and Senior Managing Engineer, February 1998 to present
HydroQual, Inc., Associate, 1990 to January 1998
U. of California, Santa Barbara, Post-Doctoral Researcher, 1986 to 1990
Hewlett-Packard Company, Development Engineer, 1981 to 1984

EDUCATION

University of California, Santa Barbara, Ph.D., Mechanical Engineering, 1986
California Institute of Technology, M.S., Applied Mechanics, 1981
University of California, Santa Barbara, B.S., Mechanical Engineering, 1980

REGISTRATION

Professional Engineer, State of New Jersey
(License No. 24GE04511700)

EXPERIENCE SUMMARY

Dr. Ziegler's expertise is in the area of contaminant fate and transport with an emphasis on the analysis of cohesive and non-cohesive sediment transport. He has developed a state-of-the-science sediment transport model (SEDZL) which is of importance in the study of waterborne pollutants in lakes, rivers, and coastal waters. Development of the sediment transport model was funded by the USEPA and the model has been used by USEPA on several contaminated sediment studies. Model validation studies on the Upper Hudson River, Lower Fox River (Wisconsin), Pawtuxet River (Rhode Island) and Watts Bar Reservoir (Tennessee) yielded excellent results. The sediment transport model has also been used in conjunction with studies of contaminant transport in the Venice Lagoon (Italy), the Trenton Channel of the Detroit River, Buffalo River, Saginaw River, Lake Erie, and the Santa Barbara Channel. Dr. Ziegler is a nationally recognized expert in the area of sediment stability and was a primary organizer of the Sediment Stability Workshop held in New Orleans in January 2002.

As the result of managing over 15 studies involving riverine transport processes, Dr. Ziegler has acquired extensive experience in this area. He has developed, calibrated, and applied one-, two-, and three-dimensional models (hydrodynamic, sediment transport, and toxics fate and transport) to aquatic systems ranging from small streams to large rivers and impoundments. Associated with the modeling work, Dr. Ziegler has also designed and conducted field studies to meet the requirements of the modeling efforts.

MAJOR PROJECTS

Contaminated Sediments Assessment and Management

Sediment Stability Analysis for the Lower Duwamish Waterway

Client: Windward Environmental/Lower Duwamish Waterway Group

Managed large-scale project to investigate stability of PCB-contaminated sediment in the Lower Duwamish Waterway, which is a salt-wedge estuary located near Seattle. Combined data-based and hydrodynamic modeling analyses to evaluate stability of contaminated sediment in the study area.

Analysis of Ice-Jam-Related Bed Scour in the Grasse River

Client: Alcoa

Managed study to evaluate bed scour due to an ice jam on the Grasse River. Used combination of stratigraphic, geomorphologic and modeling analyses to investigate impacts of ice jam on bed scour. Applied a sophisticated hydrodynamic model to study turbulent flow under an ice jam for use in designing an armored cap.

Analysis of Dredging Resuspension in the Upper Hudson River

Client: General Electric Company

Managed study to evaluate fate and transport of PCB-contaminated sediment resuspended during dredging in the Upper Hudson River. Participated in development of a hydrodynamic, sediment transport and PCB transport modeling framework that is used to simulate a dredge plume in the river for a variety of flow conditions.

PCB Fate and Transport in the Kalamazoo River

Client: Michigan Department of Environmental Quality

Managed project to perform detailed review and analysis of PCB fate and transport model developed by PRP consultant. Data analyses were completed to develop general understanding of PCB transport processes in the study area.

Analysis of the Fate of PCBs in the Housatonic River

Client: General Electric Company

Managed watershed, hydrodynamic and sediment transport studies in the Housatonic River. Extensive data analysis and modeling studies will be used to develop management tools to evaluate the appropriate remedial solution for the contaminated sediments. An important aspect of this project is the evaluation of the impact of river flooding on the transport of sediment and PCBs.

Analysis of the Fate of PCBs in the Grasse River

Client: Alcoa

Managed hydrodynamic and sediment transport modeling studies in the Grasse River. Field sampling and data analysis were incorporated into the development, calibration and validation of hydrodynamic and sediment transport models. These models were linked to a PCB fate and transport model, and the modeling framework was used to evaluate the efficacy of various remedial alternatives.

Analysis of the Fate of PCBs in the Hudson River

Client: General Electric Company

Managed hydrodynamic and sediment transport (cohesive and non-cohesive sediments) modeling studies in the Upper Hudson River. This project involved field sampling, data analysis, and model development/ calibration. The hydrodynamic and sediment transport models were linked to a PCB fate and transport model to predict the impacts of various remedial alternatives.

Development of PCB Fate and Transport Model for Lower Fox River

Client: Stratus Consulting (Boulder, CO) for U.S. Fish and Wildlife Service

As part of the Fox River/Green Bay Natural Resource Damage Assessment, managed development of hydrodynamic and sediment transport models in the Lower Fox River. These models were linked to a PCB fate model for potential use in evaluating impacts of remediation activities.

Investigation of Mercury Fate and Transport in Lavaca Bay

Client: Aluminum Company of America

Managed sediment transport modeling project in Lavaca/Matagorda Bay, which is a large, shallow estuary on the Texas Gulf Coast. Calibrated model, which includes the effects of wind wave resuspension, has been coupled to a mercury transport model to predict the fate of contaminated sediments in this system. A primary goal of this project is to evaluate the impact of hurricanes and other rare storms on buried mercury.

Modeling of Contaminant Fate in the Pawtuxet River

Client: Ciba-Geigy Corporation, Ardsley, New York

Developed and calibrated a fine-grained sediment transport model of the Pawtuxet River (Rhode Island) for use in determining the fate of contaminated sediments. The sediment transport model was calibrated and validated during a period which included two high flow events, each of which approximately correspond to the annual flood. The successful calibration exercise indicated that the model can be confidently used as a predictive tool.

PCB Fate and Transport in Watts Bar Reservoir

Client: McKenna & Cuneo, Washington, D.C. (representing Union Carbide)

Managed project to conduct technical analyses and prepare expert witness testimony for defendants (Union Carbide and Martin Marietta, past and present managers of Oak Ridge National Laboratory) in a lawsuit which alleged that past ORNL discharges of PCBs into Watts Bar Reservoir were the primary source of PCB body burden in present day fish. Developed and successfully calibrated a model of fine-grained sediment transport in the reservoir over a 30 year period. Results of the sediment transport model were coupled with a PCB fate and transport model to determine the impact of ORNL PCB discharges during this period on current catfish body burden in the reservoir.

Sediment Bed Contaminant Sampling in the Toms River

Client: Ciba Corporation, Toms River, New Jersey

Managed a sediment bed sampling program in the Toms River, which is a small river in the Pine Barren region of New Jersey. Designed and conducted sampling program to evaluate the extent of bed contamination, due to organic chemicals and metals, in a 2-mile reach of the river. Directed data analysis effort to investigate possible contaminant sources and determine aquatic biota impacts.

Preparation and Presentation of Expert Witness Testimony for L.A. County 301(h) Appeal

Client: U.S. Environmental Protection Agency, Region IX, San Francisco, California

Managed project to analyze the impacts of the L.A. County sewage outfall on benthic biota. Developed and calibrated deposition model used to simulate sediment bed fluxes of organic carbon, DDT, and heavy metals in vicinity of outfall from 1950 to 1990. Model results were used in conjunction with benthic biota data to determine current environmental impacts of solids discharges from the outfall.

Assessment of the Fate of Bentonite Clay Discharged from a Cooling Tower Outfall to Lake Erie

Client: Lonza, Inc.

The SEDZL sediment transport model was used to estimate the impact of bentonite clay release into Lake Erie following its discharge in association with controlling zebra mussels in cooling tower outfalls.

Yellow Sea Sediment Transport Modeling

Client: U.S. Navy, Naval Research Laboratory

Developed and documented three-dimensional sediment transport model for use in studying cohesive and non-cohesive sediment transport processes in coastal ocean areas. Developed interface between sediment transport and wind wave models so that effects of wave-induced resuspension can be realistically simulated. Applied modeling framework to the Yellow Sea.

Water Quality/Eutrophication Assessment

Water Quality Model of the Seneca River

Client: Onondaga County Department of Water Environment Protection

Managed development, calibration, and validation of hydrodynamic model for the Seneca River. Water quality modeling framework includes separate submodels describing: 1) time-variable hydrodynamics; 2) phytoplankton, nutrient, and dissolved oxygen dynamics; 3) sediment oxygen demand and nutrient fluxes; and 4) zebra mussel filtering and respiration activity. The model is being applied to assess the diversion of effluent from an 85 MGD wastewater treatment plant from Onondaga Lake to the Seneca River. The model will also be applied by the NYSDEC to assess TMDLs for the river.

Upper Mississippi River Eutrophication Modeling Study

Client: Metropolitan Council Environmental Services, Minneapolis/St. Paul, Minnesota

Managed hydrodynamic and sediment transport modeling study of the Upper Mississippi River. Developed and calibrated three-dimensional hydrodynamic/sediment transport model which was coupled to an eutrophication model so that the impacts of various phosphorus sources on water quality in this riverine system could be evaluated.

Delaware River Water Quality Modeling Study

Client: Delaware River Basin Commission

Managed project to develop and calibrate a three-dimensional hydrodynamic model of the Delaware River estuary. The hydrodynamic model was coupled to a water quality model so that the impacts of wastewater treatment plants on water quality in the estuary could be evaluated.

Estuarine Circulation Modeling in the Tar Pamlico River

Client: Tar Pamlico Basin Association, North Carolina

Applied a laterally-averaged hydrodynamic model to the Tar Pamlico River estuary. Good agreement was obtained between measured and predicted water elevations and salinity distributions during the one year-long (1991) model calibration/validation period. The hydrodynamic model was directly coupled to a water quality model to examine dissolved oxygen effects on bottom layer hypoxia.

Water Resources/Watershed Assessments

The Fate of Water Filtration Plant Solids Discharges in the Potomac River

Client: Washington Suburban Sanitary Commission

Managed project to evaluate the impact of various solids discharge scenarios on downstream deposition patterns in the Potomac River. A large water filtration plant near Washington, D.C. discharges residual solids back into

the freshwater portion of the Potomac River. To evaluate the efficacy of different filtration process modifications, which were necessary to meet new state requirements on solids discharge rates, a sediment transport model of a 5 km reach of the river was developed, calibrated, and applied.

Pathogen Fate and Transport

The Transport and Fate of Pathogens in Mamala Bay (Oahu, Hawaii)

Client: Mamala Bay Study Commission

Managed the hydrodynamic modeling effort associated with a large-scale project to model the transport and fate of pathogens discharged from point and non-point sources in Mamala Bay, which is the offshore region near Honolulu. The hydrodynamic model developed for this study was quite complex, involving a three-dimensional model that encircled the island of Oahu. As part of this study, Dr. Ziegler worked with researchers at MIT and Georgia Tech to develop methodologies, including an innovative particle tracking model, to accurately couple the near-field model of an ocean outfall with the far-field hydrodynamic model.

Erie Wastewater Treatment Plant Outfall Study

Client: Consoer Townsend and Associates, Inc.

Analyzed the impacts of current and proposed sewer outfall locations on bathing beach water quality in the vicinity of Erie, Pennsylvania. A risk analysis was completed, using the results of a coupled hydrodynamic/water quality model in conjunction with historical data, to statistically examine the effects of outfall discharges on beach fecal coliform concentrations.

Coastal Engineering

Modeling Study for Naval War College Breakwall Design

Client: U.S. Navy

Managed modeling study to investigate impacts of a proposed breakwall offshore of the Naval War College in Narragansett Bay, Rhode Island. Developed and applied hydrodynamic, sediment transport and wave models of the bay and study area. Used models to investigate impacts of proposed breakwall on circulation and sediment transport in the study area; examined impacts of extreme storms, including a hurricane. Determined wave climate in study area during rare storms which was used for breakwall design.

Sediment Stability Study for Former Nansemond Ordnance Depot, James River Estuary

Client: U.S. Army Corps of Engineers

Managed study to investigate sediment stability in nearshore area adjacent to Former Nansemond Ordnance Depot, located on the James River Estuary in Virginia. Hydrodynamic, sediment transport and wave models were developed and applied to the nearshore study area. The models were used to evaluate sediment stability during several extreme storm scenarios.

Expert Testimony

Contaminant Transport in the Ohio River

Client: U.S. Department of Justice

Principal investigator for analyzing contaminant transport in the Ohio River. Hydrodynamic, sediment transport and contaminant transport models for a 30-mile reach of the Ohio River were used to investigate the fate of effluent discharged into the river during summer 1999. This work is being used to provide litigation support through expert testimony.

Natural Recovery and Mercury Fate in Penobscot River Estuary. Maine Peoples' Alliance and Natural Resources Defense Council, Inc. vs. HoltraChem Manufacturing Company, LLC and Mallinckrodt, Inc.

Client: Mallinckrodt, Inc.

Principal investigator for evaluating mercury fate and transport processes in this estuary located in Maine. This study involved analyzing hydrodynamic, sediment transport and mercury concentration data to determine if natural recovery is occurring in this estuary and, if so, to estimate the rate of recovery. This work was used to provide litigation support through expert testimony.

Dr. Ziegler has also managed contaminated sediment studies of three rivers for confidential clients.

PROFESSIONAL ACTIVITIES

Affiliations

Association of Coastal Engineers
American Shore & Beach Preservation Association
ASCE Coasts, Oceans, Ports & Rivers Institute (COPRI)
American Society of Civil Engineers
International Association for Hydraulic Research

Committee Membership

ASCE Contaminated Sediments Task Committee
Sediment Stability Subcommittee, Sediment Management Work Group

Invited Participation in Technical Workshops

Sediment Stability Workshop, New Orleans, LA, January 22-24, 2002.

Modeling and Management of Emerging Environmental Issues – Expert Workshop 2000, Malvern, PA, July 25-27, 2000.

PRESENTATIONS

Conducting Sediment TMDL Studies: Lessons Learned from Large-Scale Contaminated Sediment Studies. Ziegler, C.K. and J. Benaman, 5th International Symposium on Sediment Quality Assessment, Chicago, IL, 2002.

Improvement of Sediment Transport Dynamics in HSPF. Ziegler, C.K. and C.F. Owen, WEF Watershed 2002 Conference, Fort Lauderdale, FL, 2002.

Minimal Requirements for Developing a Credible Sediment Transport Model. Ziegler, C.K., 44th Conference on Great Lakes Research, IAGLR, Green Bay, WI, 2002.

Sediment Stability at Contaminated Sediment Sites. Ziegler, C.K., 16th Annual International Conference on Contaminated Soils, Sediment and Water, Amherst, MA, 2000.

An Empirical Method for Estimating Suspended Sediment Loads in River. Ziegler, C.K. and J.P. Connolly, WEF Watershed 2000 Conference, Vancouver, BC, 2000.

Use of Models and the Scientific Method for the Evaluation of Remedial Alternatives for PCBs in the Upper Hudson River. Ziegler, C.K. and J.P. Connolly, 32nd Mid-Atlantic Industrial and Hazardous Waste Conference, Troy, NY, 2000.

Evaluating Sediment Stability at Sites with Historic Contamination. Ziegler C.K., SETAC 20th Annual Meeting, Philadelphia, PA, November 14-18, 1999.

The Impact of Sediment Transport Processes on the Fate of Hydrophobic Organic Chemicals in Surface Water Systems. Ziegler, C.K. and J.P. Connolly, Proceedings of WEF Toxic Substances in Water Environments Conference, pp. 1-13 to 1-24, 1995.

Effects of Flocculation on Particle Transport. Lick, W., C.K. Ziegler, J. Lick and A. Joshi, Estuarine and Coastal Modeling III, Proceedings of the 3rd International Conference, pp. 172-186, 1994.

A Comparative Analysis of Estuarine Circulation Simulation Using Laterally Averaged and Vertically Averaged Hydrodynamic Models. Ziegler, C.K., J.D. Bales, J.C. Robbins and A.F. Blumberg, Estuarine and Coastal Modeling III, Proceedings of the 3rd International Conference, pp. 447-460, 1994.

Transport of Sediments in the Venice Lagoon. Ziegler, C.K., C.H. Tsai and W. Lick, Proceedings of the Third International Conference on Environmental Contamination, Venice, 1988.

Resuspension, Deposition and Transport of Fine-Grained Sediments. Ziegler, C.K. and W. Lick, Proceedings of the International Conference on Fluid Mechanics, Beijing, 1987.

PUBLICATIONS

The Role of Modeling in Managing Contaminated Sediments. Jensen R.H., S.J. Bentley, M.B. Dannel, J.V. DePinto, J.A. Dyer, K.J. Farley, M.H. Garcia, D. Glaser, J.M. Hamrick, W.J. Lick, R.A. Pastorok, R.F. Schwer, C.K. Ziegler, Chapter 2 In: *Environmental Modeling and Management Theory, Practice and Future Directions,* Chien, C.C., M.A. Medina, Jr., G.F. Pinder, D.R. Reible, B.E. Sleep, C. Zheng., eds. Today Media, Inc. 2002.

Evaluating Sediment Stability at Sites with Historic Contamination. Ziegler, C.K., *Environmental Management*, 29(3):409-427, 2002.

Modeling Sediment Transport Dynamics in Thompson Island Pool, Upper Hudson River. Ziegler, C.K., P.H. Israelsson and J.P. Connolly, *Water Quality and Ecosystem Modeling*, 1:193-222, 2000.

A Model of PCB Fate in the Upper Hudson River. Connolly, J.P., H.A. Zahakos, J. Benaman, C.K. Ziegler, J.R. Rhea and K. Russell, *Envir. Sci. & Tech.*, 34(19):4076-4087, 2000.

Numerical Modeling of the Transport and Fate of Hydrophobic Contaminants and Fine-Grained Sediments in Surface Waters. Ziegler, C.K. and W. Lick, In: *Next Generation Environmental Models and Computational Methods*, Ch. 14, pp. 129-138, 1997.

Development and Calibration of a Fine-Grained Sediment Transport Model for the Buffalo River. Gailani, J., W. Lick, C.K. Ziegler and D. Endicott, *J. of Great Lakes Res.*, 22(3): 765-778, 1996.

Modeling Outfall Plume Behavior Using a Far Field Circulation Model. Blumberg, A.F., Z.G. Ji and C.K. Ziegler, ASCE *J. Hyd. Engr.* 122(11): 610-616, 1996.

Long-Term Simulation of Fine-Grained Sediment Transport in a Large Reservoir. Ziegler, C.K. and B.S. Nisbet, *ASCE J. Hyd. Engr*, 121(11): 773-781, 1995.

Sediment Transport in the Lower Saginaw River. Cardenas, M., J. Gailani, C.K. Ziegler and W. Lick, *Mar. Freshwater Res.*, 46:337-347, 1995.

The Resuspension and Transport of Fine-Grained Sediments in Lake Erie. Lick, W., J. Lick and C.K. Ziegler, *J. Great Lakes Res.*, 20(4): 599-612, 1994.

Fine-Grained Sediment Transport in Pawtuxet River, Rhode Island. Ziegler, C.K. and B. Nisbet, *ASCE J. Hyd. Engr.* 120(5): 561-576, 1994.

The Transport of Fine-Grained Sediments in the Trenton Channel of the Detroit River. Ziegler, C.K., W. Lick and J. Lick, In: *Transport and Transformation of Contaminants Near the Sediment-Water Interface*, Chap. 12, pp. 225-252, 1994.

Flocculation and Its Effect on the Vertical Transport of Fine-Grained Sediments. Lick, W., J. Lick and C.K. Ziegler, *Hydrobiologia* 235/236: 1-16, 1992.

The Transport of Suspended Solids in the Lower Fox River. Gailani, J., C.K. Ziegler and W. Lick, *J. Great Lakes Res.*, 17(4): 479-494, 1991.

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A Numerical Analysis of the Fluid Dynamics and Chemical Transport in a CVD Reactor: Planar Coordinate Model. Ziegler, C.K., W.L. Ahlgren and W. Lick, *UCSB Report* ME-90-6, 1990.

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QUALITY ASSURANCE PROJECT PLAN
REMEDIAL INVESTIGATION WORK PLAN

PATRICK BAYOU SUPERFUND SITE, DEER PARK, TEXAS

Prepared for

U.S. Environmental Protection Agency, Region 6

and the

Patrick Bayou Joint Defense Group

Prepared by

Anchor Environmental, L.L.C.

1011 DeSoto Street

Ocean Springs, Mississippi 39564

January 2007

Quality Assurance Project Plan (QAPP)
Patrick Bayou Superfund Site RI/FS
Approvals

David C. Keith — January 8, 2007

David Keith — Date

Anchor Project Manager

Susan Snyder — January 8, 2007

Susan Snyder — Date

Anchor Project Chemist

Dennis Hanzlick — January 8, 2007

Dennis Hanzlick — Date

Anchor Project QA Manager

Tom Schadt — January 8, 2007

Tom Schadt — Date

Anchor Project Director

QAPP Distribution

All group leaders and technical advisors in the distribution list provided below will receive copies of the Quality Assurance Project Plan (QAPP) for the Patrick Bayou Superfund Site Remedial Investigation/Feasibility Study (RI/FS), and any approved revisions of this QAPP. The QAPP will also be made available to any authorized party by requesting a copy from the Project Coordinator for the Patrick Bayou Joint Defense Group (JDG), Mr. Robert Piniewski of de maximis.

Distribution List

David Keith, Anchor Environmental L.L.C., Project Manager
Susan Snyder, Anchor Environmental L.L.C., Project Chemist
Dennis Hanzlick, Anchor Environmental L.L.C., Project QA Manager
Michelle McClelland, Anchor Environmental L.L.C., Data Manager
Tom Schadt, Anchor Environmental L.L.C., Project Director
Jason Kase, Anchor Environmental, L.L.C, Field Supervisor
Philip Allen, USEPA Region 6 Project Manager
USEPA Region 6 QA Officer
Mr. Robert Piniewski, de maximis, Project Coordinator for the Patrick Bayou JDG

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1 PROJECT/TASK ORGANIZATION

This Quality Assurance Project Plan (QAPP) has been developed for the tasks associated with the Remedial Investigation/Feasibility Study (RI/FS) being conducted by the Patrick Bayou Joint Defense Group (JDG). The JDG has retained Anchor Environmental to perform the RI/FS. Figure 1-1 provides an organizational chart of the key project personnel. Table 1-1 lists the names and Quality Assurance (QA) responsibilities of key project personnel who will be involved in sampling and analysis activities for the RI/FS. Note that Data Management, which is normally described in a QAPP, is described separately in the Data Management Plan (DMP) for the project (Anchor 2006c).

Table 1-1
Project Personnel Quality Assurance Responsibilities

Title	Responsibility	Name/Affiliation	Contact information
Anchor Project Director	Responsible for the overall delivery of project objectives in alignment with the operating parameters set forth in this QAPP.	Tom Schadt	Anchor Environmental, L.L.C. 1423 Third Avenue, Suite 300 Seattle, WA 98101 (206) 287-9130 tschadt@anchorenv.com
Anchor Project Manager	Responsible for the coordination and execution of all work items associated with project planning and implementation. Liaison between program-level managers and project-level team members. Identifies team members and project assignments. Manages and tracks schedule and budget. Ensures that all tasks are completed by assigned team members within schedule and budget constraints.	David Keith	Anchor Environmental, L.L.C. 1011 Desoto Street Ocean Springs, MS 39564 (228) 818-9626 dkeith@anchorenv.com
Anchor Project Health and Safety Manager	Responsible for overseeing health and safety program for field tasks associated with RI/FS. Reviews Site Health and Safety Plan, Site job safety analyses and training requirements.	Dennis Hanzlick	Anchor Environmental, L.L.C. 1423 Third Avenue, Suite 300 Seattle, WA 98101 (206) 287-9130 dhanzlick@anchorenv.com
Anchor Project QA Manager	Responsible for Data Quality Objective (DQO) planning, QAPP development, ensuring the project objectives are met. Liaison between project manager and project team. Task lead for data interpretation and final report preparation.	Dennis Hanzlick	Anchor Environmental, L.L.C. 1423 Third Avenue, Suite 300 Seattle, WA 98101 (206) 287-9130 dhanzlick@anchorenv.com
Anchor Data Manager (DM)	Point of contact for all issues concerning laboratory data, database maintenance, data loading, verifying data, and communicating with the laboratory and project team regarding database and data content issues.	Michelle McClelland	Anchor Environmental, L.L.C. 1423 Third Avenue, Suite 300 Seattle, WA 98101 (206) 287-9130 mmclelland@anchorenv.com
Anchor Project Chemist (PC)	The PC is responsible for validating the data and providing data validation flags and their meanings to the DM. The PC is responsible for validating the data according to the requirements of the Quality Assurance Project Plan and identifying and resolving any issues affecting completeness, accuracy, or usability.	Susan Snyder	Anchor Environmental, L.L.C. 1423 Third Avenue, Suite 300 Seattle, WA 98101 (206) 287-9130 ssnyder@anchorenv.com
Field Supervisor	Responsible for sample collection, sample handling, maintaining and documenting the sample chain-of-custody, delivering the samples to the	Jason Kase	Anchor Environmental, L.L.C. 1011 Desoto Street Ocean Springs, MS 39564

Title	Responsibility	Name/Affiliation	Contact information
	laboratory, and delivering the field notes, field measurements, and chains-of-custody to the DM. In addition, the Field Supervisor will implement the Health and Safety Plan in the field.		(228) 818-9644 jkase@anchorenv.com
Project Emergency Coordinator	Responsible for managing potential emergency situations during field work for the RI/FS. Includes notifying appropriate Points of Contact at each facility and the Project Manager in case of fire, spills, personal injury, or any other emergency situation that may arise.	Jason Kase	Anchor Environmental, L.L.C. 1011 Desoto Street Ocean Springs, MS 39564 (228) 818-9644 jkase@anchorenv.com
Vessel Operator	Responsible for the safe operation of boats or other sampling platforms utilized during sampling and maintenance activities. Will assure that proper safety equipment is on the vessel and operating correctly and that all personnel on the boat are familiar with safety procedures, features and equipment.	To Be Determined	
Subcontractor Laboratory Data Manager	Will enter the samples and analytical methods into the laboratory data management system according to the laboratory's Quality Assurance Plan (QAP).	To be Determined	
Subcontractor Lab Project Manager(s) (PC/LPM)	Point of contact for the laboratory. The PC communicates the sampling schedule, analytical methods, turnaround time, laboratory QA/QC, and reporting requirements.	To Be Determined	

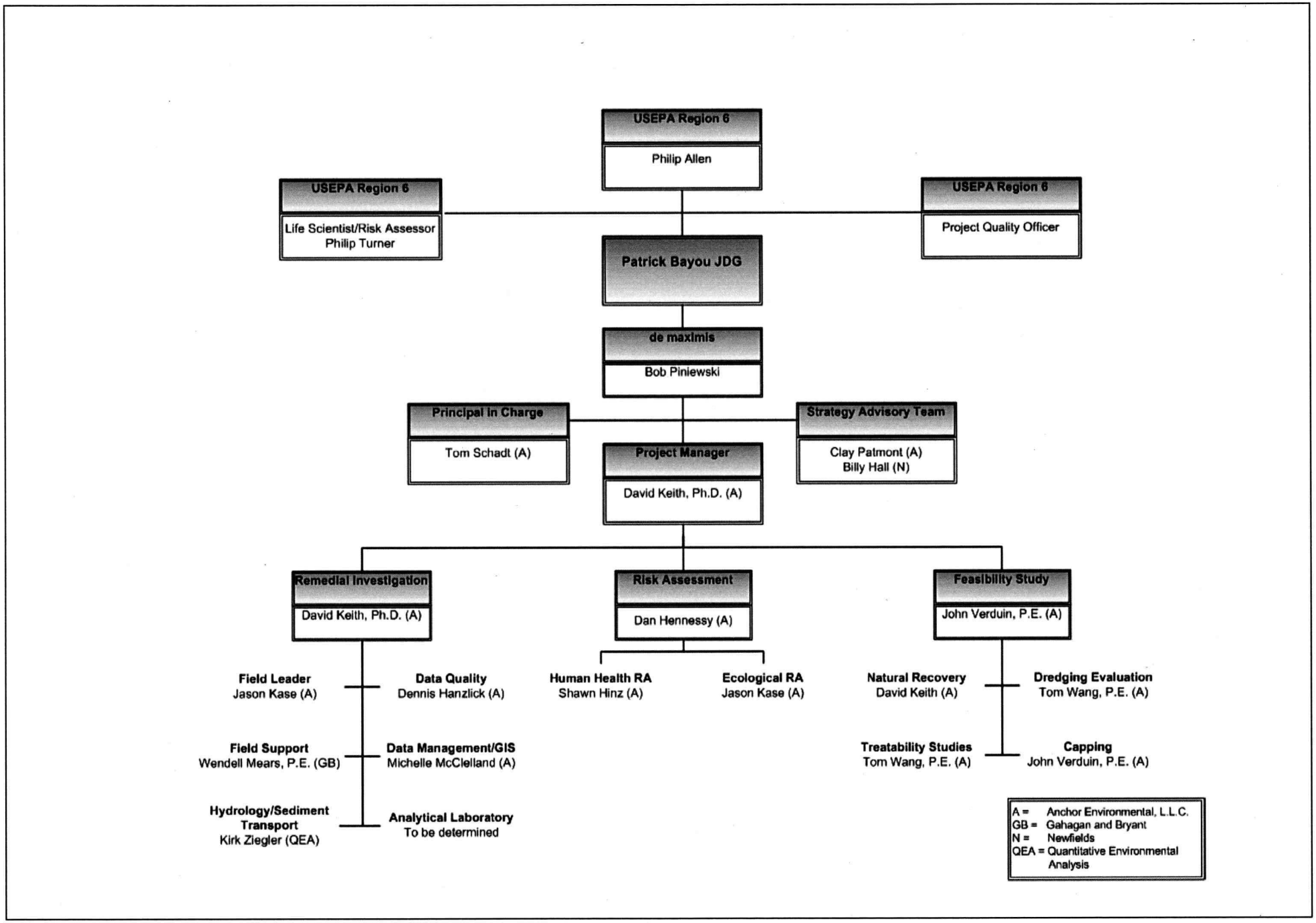

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Figure 1-1
Project Organization Chart
Patrick Bayou RI Work Plan

2 PROBLEM DEFINITION AND BACKGROUND

This section provides a brief background on the Patrick Bayou Superfund Site RI/FS and specifies the project purpose and objectives.

2.1 Background and Site History

Patrick Bayou is tributary of the Houston Ship Channel (HSC) in Harris County, Texas. The Site originates north of State Highway 225 in the City of Deer Park and flows approximately 2.5 miles in a northerly direction (Figure 2-1).

Extensive and detailed background and Site history information is available in the *Preliminary Site Characterization Report – Patrick Bayou Superfund Site, Deer Park, Texas* (PSCR, Anchor 2006a) and in the *Response to Agency Comments on the PSCR* (Anchor 2006b). Information from the PSCR is incorporated by reference into this document.

2.2 Project Purpose and Objectives

The objective of the RI is to assess Site conditions and to collect data necessary to adequately characterize the Site for the purpose of developing and evaluating effective remedial alternatives that are protective of human health and the environment. Pursuant to this objective, the RI report will assess the risk that Contaminants of Potential Concern (COPC) present for human health and the environment. The primary objective of the FS is to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action options can be presented to a decision-maker, and an appropriate remedy selected. The FS shall evaluate alternatives for addressing the impact to human health and the environment from the contamination at the Site. Interim response actions protective of human health and the environment and those that may contribute to the effectiveness of a remedial action may also be considered and implemented. A Baseline Risk Assessment will be developed to identify the existing or potential risks that may be posed by the Site to human health and the environment. This assessment also serves to support the evaluation of potential remedial alternatives by documenting the threats posed by the Site based on expected exposure scenarios. Because this assessment identifies the primary health and environmental threats at the Site, it also provides valuable input to the development and evaluation of alternatives during the FS.

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Bridges and pipelines from GBA Survey, May/June 2005.
Outfalls and culvert approximated from aerial orthoimagery and historical maps.
Stations are placed in 500-foot intervals. Station numbers indicate length along channel in hundreds of feet.
Aerial orthoimagery from USGS, June 2002.

Figure 2-1
Patrick Bayou Superfund Site Map
Patrick Bayou RI Work Plan

3 PROJECT/TASK DESCRIPTION

This section provides information on the project study area addressed in this QAPP, summarizes the work to be performed within the area, and provides a project implementation schedule.

3.1 Project Study Area

Figure 2-1 identifies the boundaries of the Site as described in the Administrative Settlement Agreement and Order on Consent (AOC). This QAPP will describe the activities associated with the acquisition of environmental information at this Site to be collected pursuant to the purpose and objectives described above.

3.2 Summary of Work

As discussed in the PSCR and the Project Management Plan (PMP) (Anchor 2006c), an adaptive management approach will be applied to the RI/FS process. This process can be considered a 'phased approach' whereby work is completed, results are evaluated, the understanding of the Site is updated, and future work plans revised or developed as appropriate. A full description of the approach, planned activities, and schedule is provided in the PMP (Anchor 2006c). This approach was approved by USEPA in a letter dated June 7, 2006.

The planned phases are described in the PMP and include the following:

- Work Package 1 – Historical Data Quality Assessment Work Plan and Identification of Preliminary Data Quality Objectives (DQOs) and Chemicals of Potential Concern (COPCs). The Work Plan for this Work Package has been submitted to USEPA and was approved on July 7, 2006.
- Work Package 2 –Hydrology and Source Evaluation
- Work Package 3 - Ecological and Human Health Risk Assessment
- Work Package 4 – Feasibility Study Engineering Data

It is expected that Work Packages 2, 3, and 4 will require the field investigation and/or collection of new data. A summary of the expected field investigations and data collection for these work packages is provided in the PMP.

3.3 Project Schedule and Data Reporting

Figure 3-1 illustrates the project schedule and reporting activities for the Patrick Bayou Superfund Site RI/FS as provided in the PMP.

ID	Task Name	Duration	Start	Finish
1	**Preliminary Site Characterization Report (PSCR)**	**106 days**	**Fri 4/28/06**	**Fri 9/22/06**
2	Submit PSCR to Agencies	1 day	Fri 4/28/06	Fri 4/28/06
3	Agency Approval of PSCR	1 day	Fri 9/22/06	Fri 9/22/06
4	**Remedial Investigation**	**673 days**	**Fri 3/24/06**	**Tue 10/21/08**
5	Prepare General RI Workplan	71 days	Fri 3/24/06	Fri 6/30/06
6	JDG Review - RI Workplan	21 days	Mon 7/3/06	Mon 7/31/06
7	EPA Review - RI Workplan	30 days	Tue 8/1/06	Mon 9/11/06
8	**Work Package #1**	**128 days**	**Fri 3/24/06**	**Tue 9/19/06**
9	Historical Data Quality Assessment and Identification of COPC and DQO Workplan	51 days	Fri 3/24/06	Fri 6/2/06
10	JDG Review - Data Quality Assessment Workplan	14 days	Mon 6/5/06	Thu 6/22/06
11	EPA Review - Data Quality Assessment Workplan	30 days	Fri 6/23/06	Thu 8/3/06
12	Draft RI Database Finalization and Identification of Preliminary COPC and DQO	33 days	Fri 8/4/06	Tue 9/19/06
13	**Work Package #2**	**396 days**	**Fri 6/2/06**	**Fri 12/7/07**
14	Phase I Hydrology and Source Evaluation Workplan	31 days	Fri 6/2/06	Fri 7/14/06
15	JDG Review - Phase I Hydrology and Source Evaluation Workplan	15 days	Mon 7/17/06	Fri 8/4/06
16	EPA Review - Phase I Hydrology and Source Evaluation Workplan	30 days	Tue 8/15/06	Mon 9/25/06
17	Phase I Hydrology and Source Evaluation Field Investigation	241 days	Mon 10/2/06	Mon 9/3/07
18	Phase I Hydrology and Source Evaluation Data Analysis	265 days	Mon 10/2/06	Fri 10/5/07
19	Draft Phase I Hydrology and Source Evaluation Report	45 days	Mon 10/8/07	Fri 12/7/07
20	**Work Package #3**	**367 days**	**Tue 1/2/07**	**Wed 5/28/08**
21	Phase I Ecological and Human Health Risk Assessment Workplan	14 days	Tue 1/2/07	Fri 1/19/07
22	JDG Review - Phase I Eco/Human Health Risk Assessment Workplan	28 days	Mon 1/22/07	Wed 2/28/07
23	EPA Review - Phase I Eco/Human Health Risk Assessment Workplan	45 days	Thu 3/1/07	Wed 5/2/07
24	Phase I Eco/Human Health Risk Assessment Field Investigations	190 days	Thu 5/3/07	Wed 1/23/08
25	Draft Ecological and Human Health Risk Assessment Report	90 days	Thu 1/24/08	Wed 5/28/08
26	**Work Package #4**	**194 days**	**Thu 1/24/08**	**Tue 10/21/08**
27	Phase I FS Engineering Data Workplan	60 days	Thu 1/24/08	Wed 4/16/08
28	JDG Review - FS Engineering Data Workplan	14 days	Thu 4/17/08	Tue 5/6/08
29	EPA Review - FS Engineering Data Workplan	30 days	Wed 5/7/08	Tue 6/17/08
30	FS Engineering Data Collection	30 days	Wed 6/18/08	Tue 7/29/08
31	FS Engineering Data Analysis	60 days	Wed 7/30/08	Tue 10/21/08
32	Draft FS Engineering Data Report	0 days	Tue 10/21/08	Tue 10/21/08

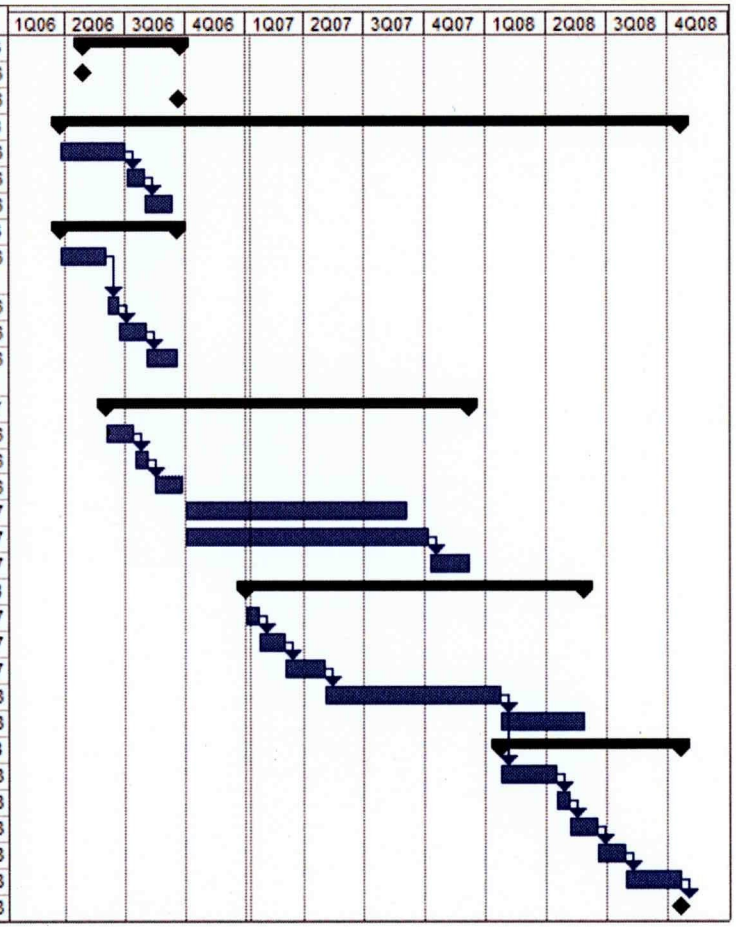

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Figure 3-1
Project Implementation Schedule
Patrick Bayou RI Work Plan

4 QUALITY OBJECTIVES AND CRITERIA

4.1 Data Quality Objectives (DQO)

The overall DQO for this project is to ensure that the data collected are of known and acceptable quality so that the project objectives described in Section 2.2 can be achieved. DQOs for work to be performed can be generally expressed in terms of the following data quality goals:

- Data should be precise, accurate, representative, comparable, and complete.
- Data should have appropriate detection limits adequate to assess attainment of risk-based criteria.
- Data should be generated using appropriate analytical support levels according to their intended use. The appropriate level of data validation to be performed for the dataset must be specified.

Additional detailed DQOs may be developed, or the DQOs summarized above may be updated or revised, as needed in future Work Plans and Sampling and Analysis Plans (SAPs).

4.2 Measurement Performance Criteria

Analytical method performance requirements are expressed in terms of precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS). Summarized below are definitions for each PARCCS parameter.

4.2.1 Precision

Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability, or random error, in sampling, sample handling, and in laboratory analysis. The American Society of Testing and Materials (ASTM) recognizes two levels of precision: repeatability—the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions; and reproducibility—the random error associated with measurements made by different test operators, in different laboratories, using the same method, but different equipment to analyze identical samples of test material.

In the laboratory, 'within-batch' precision is measured using replicate sample or quality control (QC) analyses and is expressed as the relative percent difference (RPD) between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

Field processing precision (i.e., precision of all processing and handling steps after the sample is taken) will be evaluated by the collection of blind field duplicate for chemistry samples at a frequency defined in Section 11. Field processing chemistry duplicate precision will be screened against the RPD listed in Section 11. However, no data will be qualified based solely on field processing duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit (MDL), where the percent error (expressed as RPD) increases. The equations used to express precision are as follows:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

Where:

RPD = relative percent difference

C_1 = larger of the two observed values

C_2 = smaller of the two observed values

4.2.2 Accuracy

Accuracy is the measure of agreement between an analytical result (or the mean of several results) and its true or accepted value. Deviations from a standard value represent the cumulative errors in the measurement system. Potential sources of error include (but are not limited to) sample collection, sample preservation, sample handling, matrix effects, sample analysis, and data reduction. Field sample handling accuracy is normally assessed by collecting field blanks and analyzing them for the parameters of interest. A field blank should report no targeted parameter at a concentration greater than the practical quantitation limit (PQL) or minimum reporting limit (MRL). If these

limits are exceeded, the source of contamination will be investigated and corrective action taken. Analytical laboratory accuracy is determined by comparing results from the analysis of matrix spikes, surrogates, or check standard samples to the known values. Accuracy, defined as percent recovery (P), is calculated as

$$P = \left[\frac{(SSR - SR)}{SA}\right] x\ 100$$

Where:

SSR = spiked sample result

SR = sample result (native)

SA = the spike concentration added to the spiked sample

4.2.3 Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition. Representativeness is a subjective parameter and is used to evaluate the efficacy of the sampling plan design. Representativeness is demonstrated by providing full descriptions of the sampling techniques and the rationale used for selecting sampling locations in the project planning documents. Representativeness is a qualitative parameter that will be controlled by the proper design and management of the sampling project. Good representativeness will be achieved through the following requirements:

- Careful, informed selection of sampling sites.
- Selection of testing parameters and methods that adequately define and characterize the sediment samples.
- Proper gathering and handling of samples so as to avoid interferences and prevent contamination and loss.

4.2.4 Completeness

Completeness is defined as the percentage of measurements that are judged valid compared to the total number of measurements made for a specific sample matrix and analysis. Completeness is calculated using the following formula:

$$\text{Completeness} = \frac{\text{Valid Measurements}}{\text{Total Measurements}} \times 100$$

Completeness is defined as the percentage of measurements that are judged valid measurements. Factors that negatively affect completeness include the following:

- Missing scheduled sampling events
- Submitting improper quantity of sample
- Sample leakage or breakage in transit or during handling
- Exceeding holding times
- Losing sample during laboratory analysis through accident or improper handling
- Improper documentation such that traceability is compromised
- Reported field and analytical data that is of insufficient sensitivity

The completeness requirement is based on the number of samples required by the sampling plan. A completeness objective of at least 90 percent of the data is the goal established for this project.

4.2.5 Comparability

Comparability is another qualitative measure designed to express the confidence with which one dataset may be compared to another. Sample collection and handling techniques, sample matrix type, and analytical method all affect comparability. Comparability is limited by the other PARCCS parameters because datasets can be compared with confidence only when precision and accuracy are known. Data from one phase of an investigation can be compared to others when similar methods are used and similar data packages are obtained.

4.2.6 Sensitivity

Sensitivity is the measure of the concentration at which an analytical method can positively identify and report analytical results. The sensitivity of a given method is commonly referred to as the detection limit. Although there is no single definition of this term, the following terms commonly used to measure sensitivity are defined below.

- **Instrument detection limit** (IDL) is the minimum concentration that can be measured from instrument background noise and is normally only measured for metals parameters.

- **Method detection limit** (MDL) is a statistically determined concentration. It is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero as determined in the same or a similar matrix. Because of the lack of information on analytical precision at this level, sample results greater than the MDL but less than the PQL will be laboratory qualified as "estimated."
- **Target Detection Limit** (TDL) is defined as the performance goal set between the lowest, technically feasible MDL for routine analytical methods and available regulatory criteria for evaluating the results. In the context of this sampling, the TDL is the target for the project to achieve.
- **Practical Quantitation Limit** (PQL) is the sample volume or dry weight adjusted concentration of the target analyte for which the laboratory has demonstrated the ability to measure within specified limits of precision and accuracy during routine laboratory operating conditions. This value is variable and highly matrix-dependent. The minimum concentration will be reported as "unqualified" by the laboratory. For organics analysis and inorganic ions, this corresponds to the lowest calibration standard used. It is expected the PQL will be at or below the method reporting limits listed in this QAPP.

5 SPECIAL TRAINING AND CERTIFICATION

Individuals performing work at locations where potentially hazardous materials and conditions may be encountered must meet specific training requirements. Training requirements consist of Site-specific safety instruction for each facility through the Houston-Galveston Area Council for all personnel and oversight of inexperienced personnel for one working day. In addition, a minimum of 40 hours of Occupational Safety and Health Administration (OSHA) Hazardous Waste Operator (Hazwoper) off-site training will be required for all personnel involved in activities that have a potential for exposure to contaminated media (e.g., sediment sampling and decontamination). In addition, all supervisors and managers will have completed OSHA mandatory training requirements (29 CFR 1910.120(e)(4). Any personnel involved in non-intrusive procedures (e.g., upland surveying) or who are not likely come in contact with contaminated media at the Site will be required to have a minimum of 24 hours of OSHA Hazwoper off-site training.

Surveyors will be fully trained in use of the vessel location control and data acquisition software and equipment. The field crew used to collect the various samples will be fully trained in the collection and compositing of samples, decontamination protocols, visual inspections, and chain-of-custody (COC) procedures. Additional special training or certification requirements will be described in the attachments to the SAPs as additional Work Plan packages requiring data collection are approved.

6 DOCUMENTS AND RECORDS

This section defines which records are critical to the project and what information needs to be included in reports, as well as the data reporting format and the document control procedures to be used.

6.1 Process for QAPP Document

This document was prepared following guidance presented in *EPA Requirements for QA Project Plans EPA QA/R-5* (USEPA 2001), and after review by USEPA will undergo revisions as necessary. Revisions will be tracked using the document control format recommended in the USEPA guidance and distributed to individuals indicated in the Distribution List. Once approved by USEPA, the final version of the QAPP document will be maintained by the Anchor QA Manager and Project Manager. In order to implement the adaptive management approach adopted for the Site (see the PMP, Anchor 2006c), Work Plan packages will be developed to describe additional RI/FS tasks. For those Work Plan packages that require the collection of additional data, a SAP that includes a Field Sampling Plan (FSP) and modifications or additions to this QAPP will be prepared for review and approval by USEPA prior to initiating data collection activities.

6.2 Overall Document Management

Project activities must be properly documented, and those records stored and maintained. The Anchor Project Manager will be responsible for organizing, storing, and cataloging all project information. Individual project team members may maintain separate notebooks for individual tasks and these notebooks will be transferred to the Project Manager during project closeout.

6.2.1 Project Files/Work Products/Deliverables Retention Schedule

The COC records, field forms, field notebooks and the laboratory reports are maintained in either electronic data files and/or paper data files. These are maintained on site in Anchor's Seattle, Washington office. The Anchor QA Manager will work with the designated project assistant to ensure proper preservation and access to project files. Generally, all project personnel have free access to project files, but are required to record their temporary possession of the files.

6.2.2 Final Disposition of Records

In accordance with the AOC, Anchor will preserve all documents, records, and information of whatever kind, nature, or description relating to performance of RI/FS work until 6 years after commencement of construction of any remedial action. Files that are inactive for more than 2 years may be stored off site by a document filing company. Electronic files are backed up every 24 hours in case of damage or loss of original files.

6.3 Data Reporting Package

Project documents and records from field operations, laboratory, and data handling comprise the data reporting package for this project. Specific records for each of these components are described in detail below. In addition to the data reporting package, other project records include monthly progress reports and final report documents.

6.3.1 Field Operations Records

The information contained in these records documents overall field operations and generally consists of the following:

Sample collection records. Field personnel will use a project notebook and/or field forms to record all pertinent information and to describe sampling procedures. After completion of the sampling activities, the field notebooks and field forms will be in the custody of the Project Manager. Each notebook will be identified by a project-specific document number, and each page will be numbered. Personnel will update the project notebooks daily during field activities.

All original data recorded in field forms, field logbooks, sample labels, and COC forms will be written with waterproof, indelible ink. If an error is made, the individual should make all corrections simply by crossing a line through the error, initialing and dating the correction, and entering the correct information.

Chain-of-custody records. COC records document the progression of samples as they travel from the original sampling location to the laboratory.

QC sample records. These records document the generation for QC samples, such as field, trip, and equipment rinsate blanks and duplicate samples. They also include documentation for sample integrity and preservation and include calibration and standards traceability documentation capable of providing a reproducible reference point. QC sample records should contain information on the frequency, conditions, level of standards, and instrument calibration history.

Corrective action reports. Corrective action reports show what methods were used in cases where practices deviated from general field practices or other standard procedures and include the methods used to resolve noncompliance.

6.3.2 Laboratory Records

In general, data report packages from the laboratory must contain the same documentation controls and be in a similar format as those required for contract laboratory program (CLP) organics and inorganic work. The following list describes some of the laboratory-specific records that should be compiled if available and appropriate:

- **Project Narrative.** This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss, but not be limited to, QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered, actual or perceived, and their resolutions will be documented in as much detail as appropriate.
- **Chain-of-Custody Records.** Legible copies of the COC forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- **Sample Results.** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample extraction
  - Date and time of analysis

- Weight and/or volume used for analysis
- Final dilution volumes or concentration factor for the sample
- Identification of the instrument used for analysis
- Method reporting and detection limits
- Analytical results with reporting units identified
- Data qualifiers and their definitions

- **QA/QC Summaries.** This section will contain the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). No recovery or blank corrections will be made by the laboratory. The required summaries are listed below; additional information may be requested.
- **Calibration Data Summary.** The concentrations of the initial calibration and daily calibration standards, and the date and time of analysis will be reported. This will include the response factor, percent relative standard deviation, percent difference, and retention time for each analyte as appropriate. Report results for standards to indicate instrument sensitivity.
- **Internal Standard Area Summary.** The stability of internal standard areas will be reported.
- **Method Blank Analysis.** This includes the method blank analyses associated with each sample and the concentration of all compounds of interest identified in these blanks.
- **Surrogate Spike Recovery.** This includes all surrogate spike recovery data for organic compounds, with the name and concentration of all compounds added, percent recoveries, and range of recoveries listed.
- **Matrix Spike Recovery.** This includes all matrix spike recovery data for organic and metal compounds with the name and concentration of all compounds added, percent recoveries, and range of recoveries listed. The RPD for all duplicate analyses will be included.
- **Matrix Duplicate.** This includes the RPD for all matrix duplicate analyses.
- **Relative Retention Time.** The relative retention time of each analyte detected in the samples for both primary and conformational analyses will be reported.
- **Original Data.** Legible copies of the original data generated by the laboratory will include:

- Sample extraction, preparation, and cleanup logs.
- Instrument specifications and analysis logs for all instruments used on days of calibration and analysis.
- Reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials.
- Enhanced spectra of detected compounds with associated best-match spectra for each sample.
- Printouts and quantitation reports for each instrument used including reports for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials.
- Original data quantification reports for each sample.
- Original data for blanks and samples not reported.

6.3.3 Data Handling Records

Data handling records document protocols used in data reduction, verification, and validation. Data reduction addresses data transformation operations such as converting raw data into reportable quantities and units, use of significant figures, recording of extreme values, blank corrections, etc. Data verification ensures the accuracy of data transcription and calculations, if necessary, by checking a set of computer calculations manually. Data validation ensures that QC criteria have been met.

6.4 Report Format and Document Control

The format of all data reporting packages must be consistent with the requirements and procedures used for data validation and data assessment described in Section 19 of this document. All individual records that represent action taken to achieve the objective of the data operation and the performance of specific QA functions are potential components of the final data reporting package. Data report formats are expected to be consistent with the content and format of the USEPA CLP Program.

The data reporting packages will be described in more detail in a set of project instructions to the laboratory. The laboratory project instructions include items similar to those contained in this QAPP, but tailored to provide the specific information the laboratory

requires to analyze the samples successfully and report the data back to the project. The laboratory project instructions will include the following information:

- Project personnel and contact information
- Communications procedures
- Fieldwork schedule
- Analytical methods, target parameters and required detection limits
- Hardcopy deliverable content instructions
- Electronic data deliverable (EDD) format and submittal instructions

7 SAMPLING PROCESS DESIGN

As described in the PMP (Anchor 2006c), field sampling designs for the Site will be developed through a series of SAPs prepared as part of phased Work Plan packages.

8 SAMPLING METHODS

This section will be prepared and included in the SAPs that address field activities associated with the phased Work Plan packages.

9 SAMPLE HANDLING AND CUSTODY

Components of sample custody procedures include the use of field logbooks, sample labels, custody seals, and COC forms. Each person involved with sample handling will be trained in COC procedures before the start of the field program. The COC form will accompany the samples during shipment from the field to the laboratory.

Unless specified in a subsequent SAP, these procedures will be followed.

9.1 Field Custody

The following procedures will be used to document, establish, and maintain custody of field samples:

- Sample labels will be completed for each sample with waterproof ink, making sure that the labels are legible and affixed firmly on the sample container.
- All sample-related information will be recorded in the project logbook.
- The field sampler will retain custody of the samples until they are transferred or properly dispatched.
- To simplify the COC record and minimize potential problems, as few people as possible should handle the samples. For this reason, one individual from the field sampling team will be designated as the responsible individual for all sample transfer activities. This field investigator will be responsible for the care and custody of the samples until they are properly transferred to another person or facility.
- A COC form will accompany all samples. This record documents the transfer of custody of samples from the field sampler to the laboratory. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record.
- Samples will be properly packaged for shipment and sent to the appropriate laboratory for analysis with a separate signed COC form, enclosed in a plastic bag, and taped inside the cover of each sample box or cooler. The original record will accompany the shipment, and a copy will be retained by the Field Supervisor. When samples are relinquished to shipping companies for transport, the tracking number will be recorded on the COC form.
- The COC must be signed when relinquished by field personnel and signed by the laboratory receiving the samples.

- Custody seals will be used on the shipping containers when samples are shipped to the laboratory to inhibit sample tampering during transportation.

9.2 Laboratory Sample Custody

Each laboratory receiving samples for this project must comply with the laboratory sample custody requirements outlined in its Quality Assurance Plan (QAP). The laboratory will designate a sample custodian who will be responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody. In addition, the laboratory will provide the following quality checks:

- The laboratory will check to see that there has been no tampering with the custody seals on the coolers.
- Upon receipt of the samples, the custodian will check the original COC and request-for-analysis documents and compare them with the labeled contents of each sample container for corrections and traceability. The sample custodian will sign the COC and record the date and time received in the 'Received by Laboratory' box.
- The sample custodian also will assign a unique laboratory sample number to each sample.
- Cooler temperature will be checked and recorded.
- Care will be exercised to annotate any labeling or descriptive errors. If discrepancies occur in the documentation, the laboratory will immediately contact the sample tracking coordinator and Project Chemist as part of the corrective action process. A qualitative assessment of each sample container will be performed to note anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming COC procedure.

Samples will be stored in a secured area and at a temperature of 4 °± 2°C, if necessary, until analyses are to begin. Unless otherwise specified by the Project Manager, samples will be retained for a period of 60 days after the final report is released by the laboratory after which they will be disposed in accordance with the laboratory Standard Operating Procedures (SOP) for waste disposal.

9.3 Sample Packing and Shipping

During the field efforts, the Anchor Project Chemist will notify the appropriate laboratories about sample shipments. The Field Supervisor will fax copies of the COC to the Laboratory Project Manager for each day of sampling.

Hard plastic ice chests or coolers with similar durability will be used for shipping samples. The coolers must be able to withstand a 4-foot drop onto solid concrete in the position most likely to cause damage. Samples will be double-bagged in Ziploc bags and grouped by sample set. Styrofoam or bubble wrap will be used as packing material to protect the samples from leakage during shipment. A volume of ice approximately equal to the sample volume should be present in each cooler. Blue ice will not be used. After packing is complete, the cooler will be taped securely, with custody seals affixed across the top and bottom joints. In addition, these procedures will be followed when packing coolers of samples for shipping:

1. Include absorbent material in the cooler to absorb any ice melt.
2. Record the airbill on each COC.
3. List the appropriate contact person on the COC
4. Use custody seals on the cooler.

Samples being analyzed by laboratories outside of the local area will be shipped priority overnight FedEx (or equivalent) to the laboratory. Samples that are being analyzed by laboratories in the local area will be delivered by the sampling team or picked up by courier on a daily basis. Laboratory contacts and addresses will be documented in attachments to the SAPs as they are identified.

10 ANALYTICAL METHODS

Analytical methods and the associated method reporting limits for physical and chemical analytes will be issued with SAPs as Work Plan packages are developed. Field activities associated with a Work Plan package will not be implemented until the associated SAP has been reviewed and approved by USEPA.

11 QUALITY CONTROL

This section identifies required measurement QC checks for both the field and the laboratory.

11.1 Field Quality Control and Corrective Action

Field QC samples that will be collected as part of the QC program are described below. Although validation guidelines have not been established for field QC samples, their analysis is useful in identifying possible problems resulting from sample collection or sample processing in the field. The frequency of collection for the field QC samples is listed in Table 11-1 and will be applied to all field activities unless specified otherwise in subsequent modifications to the QAPP through SAPs approved by USEPA.

11.1.1 Field Corrective Action

Any problems encountered in the field should be documented. If general field practices or other standard procedures were deviated from, those deviations and any corrective actions will be noted in the field logbook. Corrective actions may include:

- Correcting COC forms
- Changing procedures to correct problems in sample collection, packing, and shipping
- Evaluating and amending sampling procedures
- Re-sampling

11.2 Laboratory Quality Control and Corrective Action

A description and frequency of collection for the laboratory QC samples is listed in Table 11-1 and will be applied to all laboratory activities unless specified otherwise in subsequent SAPs approved by USEPA.

Results of the QC samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the Project QA Manager will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

All primary chemical standards and standard solutions used in this project will be traceable to documented, reliable commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

Table 11-1
QA/QC Procedures and Frequency

QC Check	Information Provided	Description
Blanks		
Equipment Rinse Field Blank for Water Samples	Contamination from total sampling procedure	Samples of reagent grade, analyte free water passed through and over the surface of decontaminated water sampling equipment. Equipment rinse field blanks are used to monitor the effectiveness of the decontamination process. The rinse water is collected in sample bottles, preserved, and handled in the same manner as the samples. One Equipment rinse field blank will be collected for each water sampling event or each type of sampling equipment, whichever is more frequent, and analyzed for the same parameters as the corresponding samples.
Trip Blank	For volatile compounds to assess contamination during shipping and field handling procedures	Clean sample of a matrix that is taken from the laboratory to the sampling site and transported back to the laboratory without having been exposed to sampling procedures. One per container shipped to the laboratory for analysis of volatile compounds
Temperature Indicator	Used to evaluate if samples were adequately cooled during sample shipment	Vial or other small sample bottle filled with distilled water that is placed in each cooler and upon arrival at the laboratory, temperature of this vial is measured. Alternative methods, such as direct measurement using a calibration infrared thermometer, are acceptable as well. One per container shipped to the laboratory
Laboratory Method Blank	Contamination from laboratory procedure	Samples of reagent water processed through the analytical procedure to monitor lab contamination. One per analytical batch of 20 field samples or less
Spikes		
Matrix Spike/Spike Duplicate	Analytical bias due to matrix and method	Laboratory QC samples designed to monitor the effect of the sample matrix on the accuracy and precision of analytical results. 5 percent of samples (minimum one pair per matrix)
Laboratory Blank Spike	Analytical bias due to method	Laboratory QC samples designed to monitor the effect of the method on the accuracy and precision of analytical results. One per analytical batch of 20 field samples or less
Surrogate Spike	Analytical method bias	Compounds added to each organics sample to assess bias of the analytical procedure. Added to every organic sample

QC Check	Information Provided	Description
Calibration Check Samples		
Continuing Calibration Blanks	Stability of calibration baseline	Verify the system is contamination free when continuing calibration verification standards are analyzed. Daily or as per method requirements, whichever is greater
Continuing Calibration Verification	Calibration drift	Assesses calibration accuracy on day of analysis using calibration standards. Also applies to continuing calibration of field measurement equipment, which will be calibrated as specified for each type of field equipment in subsequent SAPs. Daily or as per method requirements; whichever is greater
Secondary or Independent Calibration Verification	Calibration accuracy	Independent check of calibration accuracy using newly prepared standards after calibration but prior to sample analysis. Each time initial calibration is performed
Replicates		
Field Duplicates	Precision of all steps after sample is taken	"Blind" to the laboratory, collected to monitor the precision of the field sampling process. The identity of the duplicate field samples will be recorded in the field-sampling logbook, and this information will be forwarded to the Project QA Manager to aid in the review and evaluation of the data. The Field Supervisor will choose at least 5 percent of the total number of sample locations known or suspected to contain moderate contamination as the duplicate field samples.
Laboratory Replicates	Analytical precision	Analytical duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical duplicates are subsamples of the original sample and are prepared and analyzed as a separate sample. One per analytical batch per matrix of 20 field samples or less

12 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Equipment and instruments used during sampling activities will be cleaned and properly stored upon return from the field. Equipment decontamination will be performed as outlined in field sampling plans. Malfunctions will be repaired or reported to the designated equipment specialist as soon as possible. All field instruments and sampling equipment will be stored in a manner to maintain their accuracy. Calibrations will be conducted as outlined in instrument manuals. Field personnel will routinely clean, calibrate, check batteries, and saturate field probes or meters to ensure their reliability for field sampling. Instruction and maintenance logs and records of repair for all field equipment will be noted in the field logbook.

Preventive maintenance is performed according to the procedures delineated in the manufacturers' instrument manuals, including lubrication, source cleaning, detector cleaning, and the frequency of such maintenance.

Precision and accuracy data are examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance will be performed when an instrument begins to degrade, as evidenced by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet any of the QC criteria.

13 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Field instrument calibration and frequency shall be in accordance with manufacturer's specifications and/or following procedures in specific SAPs as necessary for the field equipment being proposed.

Laboratory instruments will be calibrated in accordance with the manufacturer's directions and appropriate method requirements. The laboratory calibration procedures will be summarized in the Laboratory QAP or method SOP. It is expected that multipoint initial calibration will be performed on each instrument at the start of each year of monitoring, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet control criteria.

All project samples analyzed while instrument calibration was out of control will be reanalyzed.

14 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Inspection and acceptance of field supplies including laboratory prepared sampling bottles will be performed by the Field Supervisor. All primary chemical standards and standard solutions used in this project, either in the field or laboratory, will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

Pre-cleaned and certified sample containers will be purchased and shipped to the field site before sample collection. The laboratory will add all preservatives before bottles are shipped to the field. The laboratory will retain all certificates of analysis for the pre-cleaned containers and note the lot numbers of bottles shipped for this project in the laboratory project file.

15 NON-DIRECT MEASUREMENTS

Non-direct data for this project includes existing environmental data for the Site and is described in Section 3 of the PSCR (Anchor 2006a). *Work Package 1 – Historical Data Quality Assessment Work Plan and Identification of Preliminary DQOs and COPCs* describes the tasks that will be undertaken to validate and verify the existing environmental data available for the Site, including development of performance and acceptance criteria for existing data. Work Package 1 was submitted to USEPA and USEPA issued approval on July 7, 2006. Deliverables associated with this Work Package are incorporated by reference into this section of the QAPP.

16 ASSESSMENT AND RESPONSE ACTIONS

16.1 Assessment

The Project Manager and the review team will monitor and audit the performance of the QA procedures. When necessary, the review team will conduct field audits. Audits may be scheduled to evaluate the execution of sample identification, sample control, COC procedures, field notebooks, sampling procedures, and field measurements.

All laboratory audit reports will be made available to the Project QA Manager upon request. All laboratories are required to have written procedures addressing internal QA/QC; these procedures have been submitted and will be reviewed by the Project QA Manager to ensure compliance with the QAPP. The laboratory will, as part of the audit process, allow review of written details of any and all method modifications planned. All laboratories must ensure that personnel engaged in sampling and analysis tasks have appropriate training. If necessary, external on-site laboratory audits will be carried out to cover analytical methodology QC procedures.

16.2 Response Actions

Response Action for Field Sampling. The Field Supervisor will be responsible for correcting equipment malfunctions during the field sampling effort. The Project QA Manager will be responsible for resolving situations identified by the Field Supervisor that may result in noncompliance with this QAPP. All corrective measures will be immediately documented in the field logbook.

Responsive Action for Laboratory Analyses. All laboratories are required to comply with their SOPs. The Laboratory Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The Laboratory Project Manager will be notified immediately if any QC sample exceeds the project-specified control limits. The analyst will identify and correct the anomaly before continuing with the sample analysis. The Laboratory Project Manager will document the corrective action taken in a memorandum submitted to the Project QA Manager within 5

days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (e.g., recalculation, reanalysis, or re-extraction) will be submitted with the data package in the form of a cover letter.

17 REPORTS TO MANAGEMENT

QA reports will be prepared by the Project QA Manager that document implementation of the QAPP and the results of the site-specific QA/QC audits. A final QA report will be submitted by the Project QA Manager to management as part of the final report. This report will contain all results, data qualifiers, results of QA checks, deviations, and corrective actions taken for the sampling and analysis covered by this QAPP and any attachments. Any major deviations from procedures or corrective actions will be briefly described.

18 DATA REVIEW, VALIDATION, AND VERIFICATION

Data review and validation are processes whereby data generated in support of this project are reviewed against the QA/QC requirements. The data are evaluated for precision, accuracy, and completeness against the analytical protocol requirements. Nonconformances or deficiencies that could affect the usability of data are identified as noted. The conventional approach to data validation involves the *USEPA Laboratory Data Validation Functional Guidelines* (USEPA 1999 and 2004). The data validation process and data management are described in the project DMP (Anchor 2006d).

19 VERIFICATION AND VALIDATION METHODS

All laboratory data will be reviewed and verified to determine whether all DQOs (Section 4 and specific DQOs in subsequent SAPs describing the sampling event) have been met, and that appropriate corrective actions have been taken, when necessary. The Project QA Manager or designee (e.g., Project Chemist) will be responsible for the final review of all data generated from analyses of samples.

The first level of review will take place in the laboratory as the data are generated. The laboratory Project Manager or designee will be responsible for ensuring that the data generated meet minimum QA/QC requirements and that the instruments were operating under acceptable conditions during generation of data. DQOs will also be assessed at this point by comparing the results of QC measurements with pre-established criteria as a measure of data acceptability.

The analysts and/or Laboratory Project Manager or designee will prepare a preliminary QC checklist for each parameter and for each sample delivery group (SDG) as soon as analysis of an SDG has been completed. Any deviations from the DQOs listed on the checklist will be brought to the attention of the Laboratory Project Manager to determine whether corrective action is needed and to determine the impact on the reporting schedule.

Data packages will be checked against the COC and QAPP for data completeness by the Project Chemist or designee immediately upon receipt from the laboratory to ensure that data and QA/QC information requested are present. Unless specified in subsequent SAP, a 10 to 20 percent data review will then be performed by a qualified data validation specialist designated by the Project Chemist on the data, in accordance with EPA National Functional Guidelines (USEPA 1999 and 2004). A full data review will be performed if substantial problems are identified in the initial review by the Project Chemist. The data will be evaluated in accordance with this QAPP. All chemical data will be reviewed with regard to the following, as appropriate to the particular analysis.

- COC/documentation
- Holding times
- Initial calibrations
- Continuing calibrations
- Method blanks

- Detection limits
- Surrogate recoveries
- Matrix spike/matrix spike duplicate recoveries
- Laboratory control sample recoveries
- Laboratory and field duplicate RPDs
- Holding times
- Standard reference material results

The data will be validated in accordance with the project-specific DQOs, analytical method criteria, and the laboratory's internal performance standards based on their SOPs.

20 RECONCILIATION WITH USER REQUIREMENTS

The QA Manager will review data after each survey to determine if DQOs have been met. If data do not meet the project's specifications, the QA Manager will review the errors and determine if the problem is due to calibration/maintenance, sampling techniques, or other factors, and will suggest corrective action. It is expected that any problem encountered would be able to be corrected by retraining, revision of techniques, or replacement of supplies/equipment. If not, then the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the QA Manager will recommend appropriate modifications. Any revisions would need approval by the USEPA.

21 REFERENCES

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DATA MANAGEMENT PLAN
REMEDIAL INVESTIGATION WORK PLAN

PATRICK BAYOU SUPERFUND SITE, DEER PARK, TEXAS

Prepared for

U.S. Environmental Protection Agency, Region 6

and the

Patrick Bayou Joint Defense Group

Prepared by

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January 2007

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1 INTRODUCTION

This Data Management Plan addresses activities associated with managing new data and existing data associated with the Remedial Investigation/Feasibility Study (RI/FS) at the Patrick Bayou Superfund Site (Site) in Deer Park, Texas. The work will be performed by Anchor Environmental L.L.C. (Anchor) and its subcontractors on behalf of the Patrick Bayou Joint Defense Group (JDG). The JDG consists of the respondents to an Administrative Settlement Agreement and an Order on Consent (AOC) with USEPA dated January 31, 2006. The JDG includes Shell, OxyVinyls, and Lubrizol Corporation.

The purpose of this document is to describe the approaches and process that will be implemented to document the quality and validity of field and laboratory data compiled during the Patrick Bayou Superfund Site (Site) Remedial Investigation/Feasibility Study (RI/FS).

2 DATA MANAGEMENT SYSTEM AND WORKFLOW

The data associated with the Patrick Bayou Superfund Site RI/FS will be managed using the EQuiS® Chemistry version 3.7.3 (Earthsoft, Inc.). EQuiS uses a relational database to manage, process, and report data associated with environmental activities. EQuiS is paired with Environmental Systems Research Institute's (ESRI's) ArcView to report and analyze data spatially.

EQuiS facilitates a data management workflow that allows users to manage data efficiently; identify potential data discrepancies, redundancies, or gaps; and maintain an audit trail from the final result back to its hard copy laboratory report. In addition to chemical data, EQuiS manages sample location and field measurement data.

3 FIELD COLLECTED DATA

To avoid alteration, damage, or loss of field data during the RI/FS, a field data security system will be put in place and will include use of personnel specifically trained in documentation and chain-of-custody (COC) requirements. Field data sheets will be checked for completeness and accuracy by the Field Supervisor. Project personnel quality assurance responsibilities are presented on Table 1-1 in the Quality Assurance Project Plan (QAPP).

Samples, sample label information, COC seals (if applicable), and COCs will be examined by the Laboratory Manager upon receipt to be sure samples are within holding times, sample identification information is legible and consistent with COC forms, and samples are being held appropriately as defined by the project QAPP. Any samples that are not acceptable per the QAPP will be marked on the COC and it will be determined in consultation with the Field Supervisor per the QAPP whether laboratory analysis should proceed. If laboratory analysis does proceed, the resulting data will be given an appropriate qualifier as noted on the COC by the laboratory upon reporting results.

All original data generated in the field will be documented on hard copy and provided to the Anchor Data Manager for review and the person designated by the Anchor Data Manager as responsible for the data's entry into the EQuIS database. All (100 percent) manually entered data will be checked by a second party designated by the Anchor Data Manager. Field data and additional documentation such as general field notes will be filed in the main project file, after data entry and checking is complete.

4 CHEMICAL ANALYTICAL DATA

Laboratory analytical samples will be collected and recorded on the COC forms provided by the laboratory. Upon receipt, the Laboratory Data Manager will enter the samples and analytical methods into the laboratory data management system according to the laboratory's Quality Assurance Plan (QAP). The result is an electronic inventory of samples and the analytical methods the laboratory should conduct for each sample.

The laboratory will deliver data to the Anchor Data Manager in electronic and hard copy format. The laboratory will use EQuiS®-specific table structures and valid values to ensure efficient data loading into EQuiS®. Diagnostics on the electronic data will be run using EQuiS®. All valid value fields will be checked against the valid value tables in EQuiS® and several automatic logic checks will be performed to identify potential errors, omissions, or redundancies in the electronic data. Any discrepancies or omissions will be discussed and resolved between the Anchor Data Manager and the Laboratory Data Manager. The Anchor Data Manager will make changes to the electronic deliverable only when directed in writing from the Laboratory Data Manager. If significant errors or omissions exist, the Anchor Data Manager will request a redelivery of the data.

Descriptive data such as the sample media, depth, sampling method, sample location/coordinates, sample type, sampling personnel, date, time, and laboratory analysis are entered at this time from field notebooks and/or completed field forms. Any discrepancies or omissions will be discussed and resolved between the Anchor Data Manager and the Field Supervisor. The Anchor Data Manager will make changes to the field information only when directed in writing from the Field Supervisor. Once the data are error-free and the field information has been added, the data will be uploaded into the project database.

After the data has been through the electronic diagnostics and field data entry process, and are error-free, the Anchor Data Manager will create a printout of the data and verify 100 percent of the laboratory detected data and 10 percent of the laboratory non-detect data against the hard copy.

This process will continue until all of the sample data expected have been uploaded and are error-free.

5 DATA VALIDATION

The Anchor Project Chemist will be given the original hard copy report from the laboratory. Validation will be performed by the Anchor Project Chemist or by an Anchor designated qualified subconsultant specializing in chemistry data validation who is directed by the Anchor Project Chemist. Validation will be performed on the hard copy data in accordance with the QAPP. Validation flags (if required) will be made in red pen directly on the laboratory report. As the data is validated, the Anchor Project Chemist will initial and date each page of the report. The validated data package will be delivered to the Anchor Data Manager. The Anchor Data Manager then will use EQuiS to call up each result needing a change. The change is added to the database manually by the Anchor Data Manager. When the Anchor Data Manager completes updating validation flags for a laboratory report, he/she will print out a report and verify 100 percent of the changes against the hard copy. Any errors or omissions will be corrected by the Anchor Data Manager.

6 SPATIAL DATA

Sample coordinates will be delivered by the Field Supervisor electronically to the Anchor Data Manager. The Anchor Data Manager or Geographic Information System (GIS) project analyst will verify that the coordinate system and datum correspond to the requirements in the Work Plan and QAPP. The Anchor Data Manager or designated GIS project analyst will load the coordinates into EQuiS® and will make a simple map of the locations. The map will be verified by the Field Supervisor to identify any mislabeled or missing locations. The Anchor Data Manager will verify that coordinates have been delivered for every sample location. Any discrepancies, omissions, or redundancies will be resolved by the Field Supervisor and corrections will be provided to the Anchor Data Manager.

A base map will be compiled in ArcView by the GIS project analyst using the existing data available. Any additional spatial data layers or features added by Anchor through field collection or other activities will be documented in by the GIS project analyst in the project data dictionary including the source, data loaded, who loaded the data, and description of the feature.

7 DATA REDUCTION AND REPORTING

When all the sample data have been received, tested, loaded, and validated, the Anchor Data Manager will use EQuiS® to reduce and report the results. Units are standardized; field duplicates, re-analyses, replicates, and dilutions are reduced; and a flag identifies which result to report. The Anchor Data Manager will then generate a series of data reports and summary tables as directed by the project team. The GIS project analyst will link the tabular data to the project GIS files and will generate a series of maps to represent the data spatially as directed by the project team.

The compiled and validated database will be electronically submitted as required to USEPA in Microsoft Access compatible format.

8 DATA HANDLING

The COC records, field forms, field notebooks and the laboratory reports will be maintained in either electronic data files and/or paper data files on-site in Anchor's Seattle, Washington office.

The Anchor Quality Assurance Manager will work with the designated project assistant to ensure proper preservation and access to both electronic and paper project files.

Paper files that are inactive for more than 2 years will be kept off-site by a document filing company contracted by Anchor. Generally, all project personnel will have free access to paper project files containing original data for viewing, but will be required to record their temporary possession of the files. Only the Anchor Project Chemist, Field Supervisor, and/or Anchor Data Manager are able to make changes to information in files once data recording for those files has stopped. Any changes will follow the procedures described in previous sections.

Electronic files will be backed up every 24 hours in case of damage or loss of original files. All project personnel will also have free access to electronic files for viewing. Software used to retain electronic files tracks "possession" of the file at any given moment Changes to original data in electronic files can only be made by the personnel noted above, using the procedures noted above. To prevent multiple versions of the electronic files, only files held in the central file will be considered valid. In the unlikely event that data changes are made to a central electronic file by someone other than the above approved personnel, the altered file will be discarded and the back up of the previous central file will be recovered in its place. All completed and validated data will be electronically submitted to USEPA in an Access compatible format at intervals as agreed upon with the USEPA remedial project manager.

HEALTH AND SAFETY PLAN
REMEDIAL INVESTIGATION WORK PLAN

PATRICK BAYOU SUPERFUND SITE, DEER PARK, TEXAS

Prepared for

U.S. Environmental Protection Agency

and the

Patrick Bayou Joint Defense Group

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January 2007

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1 INTRODUCTION

This site-specific health and safety plan (HASP) conforms to the Anchor Environmental, L.L.C. (Anchor) corporate health and safety program for conducting field activities that may have associated safety and health hazards. This HASP covers elements as specified in 29 CFR 1910.120. This HASP addresses activities associated with the collection of new data and other field activities associated with the Remedial Investigation/Feasibility Study (RI/FS) at the Patrick Bayou Superfund Site (Site) in Deer Park, Texas. The work will be performed by Anchor and its subcontractors on behalf of the Patrick Bayou Joint Defense Group (JDG). The JDG consists of the respondents to an Administrative Settlement Agreement and an Order on Consent (AOC) with USEPA dated January 31, 2006. The JDG includes Shell, OxyVinyls, and Lubrizol Corporation.

The Site will be accessed through four privately owned facilities: Shell Oil - Deer Park Refining Services, Shell Chemical L.P. – Deer Park Chemical Plant, Lubrizol Corporation, and OxyVinyls L.P. The following personnel are facility-specific points of contact (POC) that will oversee the field activities occurring at their respective facilities:

- Joe Phillips – Shell Oil - Deer Park Refining Services (Primary Contact)
- Jeff Stevenson – Shell Chemical - Deer Park Chemical Plant (back up for Shell)
- Norman Mollard – Lubrizol Corporation
- Jeff Adamski – OxyVinyls

Contact information for each of these POCs is provided in Table 1-1 below and in Attachment A.

Table 1-1
Facility Points of Contact

Shell Chemical LP	OxyVinyls	Lubrizol Corporation
Joe Phillips Phone: (713) 246-1229 Pager: (713) 606-4497 Jeff Stevenson Phone: (713) 246-4680 Pager: (713) 606-4475	Jeff Adamski Phone: (281) 476-2628 Mobile: (281) 881-4892	Norman (Wes) Mollard Phone: (832) 260-7846 Mobile: (832) 689-6190

All Anchor field personnel, subcontractors, and visitors involved in fieldwork on this project are required to comply with this HASP. The contents of this HASP include the types of activities to be performed, the physical characteristics of the sampling areas, and preliminary chemical data from previous investigations. The HASP may be revised based on new information and/or changed conditions during Site activities. Revisions will be documented in the HASP as addenda.

The work being performed at this Site and covered by this safety plan will include activities and/or Site access at four facilities. Each facility has plant-specific safety requirements. Specific requirements, as covered in site-specific safety training, or subsequent briefings, will be followed when personnel are performing activities on the respective facility's property. The facilities include OxyVinyls, Shell Oil, and Lubrizol. Otherwise, requirements and responsibilities as described in this document will apply to all work being performed, regardless of facility. Prior to the performance of work within the Bayou or for access through any one of the facilities, all work crews will complete mandatory facility Health and Safety orientation.

Section 12 of this document is an emergency response plan. Emergency telephone contacts and emergency procedures, including maps and detailed written directions to the nearest emergency medical facilities are included in Attachment A and in Figure 12-1.

2 SITE DESCRIPTION AND PROJECT SCOPE

2.1 Site Description

The Site is a tidally influenced bayou and tributary to the Houston Ship Channel that has been significantly modified to also function as a drainage for municipal and industrial discharges (a designated use for the Site). A description of the Site, its history, a summary of historical data, and a preliminary Conceptual Site Model are provided in the Preliminary Site Characterization Report (PSCR; Anchor 2006a), and in the Responses to Comments on the PSCR (Anchor 2006b). The text below provides a very general overview of the Site based on analyses performed for the PSCR.

There are a large number of historical environmental investigations and data associated with the Site, especially with regards to Total Maximum Daily Load (TMDL) investigations relating to sediment toxicity, dissolved copper concentrations in surface water, ambient water toxicity, and surface water temperature. In addition, other investigations were performed by the City of Houston, the Texas Natural Resource Conservation Commission (TNRCC) (later known as the Texas Commission on Environmental Quality (TCEQ), and the USEPA. These investigations and their data show that sediments at the Site are impacted by a variety of potential contaminants including polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, metals including mercury, dioxins and furans, hexachlorobenzene, and hexachlorobutadiene among others.

The Site is complicated by the fact that it drains large off-site surface areas under dynamic conditions. These conditions are governed by intense thunderstorms and other precipitation events that produce large amounts of runoff and substantially increased flow amounts and velocities. There is an apparent reflection of these dynamic conditions in the historical sediment chemistry and toxicity data that in some cases shows variations that are above those that can be explained by simple sediment heterogeneity or depositional patterns under more quiescent conditions.

In addition to potential historical and ongoing upstream surface water contaminant sources, shallow groundwater, surface water, air emissions, and other upland sources that enter into the Bayou from adjacent industrial facilities have the potential to impact the Site. Impacts associated with these potential sources are being addressed under applicable TCEQ

regulatory programs for each of the industrial facilities that surround the Bayou. The intent of the RI/FS team is to integrate the findings of each of the facilities' TRRP programs as they relate to potential impacts to Site surface water, sediments, and ecological and human receptors. The facilities' contractors and the RI/FS team will work together to identify data gaps that may exist and identify data quality objectives, sampling plans, and roles and responsibilities for filling those data gaps as the project moves forward.

2.2 Scope and Duration of Work

This general HASP will cover work expected to be performed during the Patrick Bayou RI/FS. As such, this HASP will address field work activities associated with the following tasks:

- Hydrology and Source Evaluation – This task is expected to include field work to install long-term water quality instruments in Patrick Bayou, collection of sediment cores to evaluate physical stability of sediments, and collection of surface water and sediment for physical and chemical analysis at the Site.
- Ecological and Human Health Risk Assessment – This task is expected, at a minimum, to include field work to collect surface water and sediment (cores and surface grabs) at the Site for physical and chemical analysis. Biological data collection and field surveys may be developed for this task. However, given the uncertain nature of these tasks at this point in the planning process, field activities associated with these tasks will be addressed as an addendum to this general task as more precise information becomes available.
- Feasibility Study Engineering Data – This task may include the collection of physical data describing sediments at the site. Field activities may specifically include collection of sediment cores for physical and chemical analysis. It is not expected that borings (e.g. standard penetrometer tests [SPT] or cone penetrometer tests [CPT]) will be included in this task.

If activities required to complete the above tasks are not included in the HASP, an addendum will be prepared for approval by the JDG and USEPA prior to initiation of any field work.

The current schedule for field activities associated with the tasks above is as follows:

- Hydrology and source evaluation field investigation
  - Anticipated Start: September 2006
  - Estimated Duration (initial phase): 15 working days
- Risk assessment field investigation and abiotic (sediment and surface water) media sampling
  - Anticipated Start: January 2007
  - Estimated Duration (initial phase): 25 working days
- Engineering data field investigation
  - Anticipated Start: October 2007
  - Estimated Duration: 15 working days

3 HEALTH AND SAFETY PERSONNEL

Key health and safety personnel and their responsibilities are described below. These individuals are responsible for the implementation of this HASP.

Project Manager – David Keith, Ph.D. (Anchor): The Project Manager (PM) has overall responsibility for the successful outcome of the project. The PM will ensure that adequate resources and budget are provided for the health and safety staff to carry out their responsibilities during fieldwork. The PM, in consultation with the Health and Safety Manager (HSM), makes final decisions concerning implementation of the HASP. Dr. Keith reports directly to the Project Coordinator for the Patrick Bayou Joint Defense Group (JDG), Mr. Robert Piniewski of de maximis.

Field Supervisor – Jason Kase (Anchor): Mr. Kase or a designee will serve as the Field Supervisor. The Field Supervisor will support field activities and coordinate between the technical and health and safety components of the field program. The Field Supervisor also has the authority to stop work if conditions arise that pose an unacceptable health and safety risk to field crew. The Field Supervisor will also be responsible for ensuring the implementation of this HASP. The Field Supervisor is responsible for initiating changes to the HASP, which must be approved by the HSM. The Field Supervisor or designee shall be present during field activities.

Project Health and Safety Manager – Dennis Hanzlick, Ph.D. (Anchor): The HSM has overall responsibility for preparation, approval, and revisions of this HASP. The HSM will not necessarily be present during fieldwork, but will be readily available, if required, for consultation regarding health and safety issues during fieldwork.

Vessel Operator – TBD: The vessel operator and the Field Supervisor will coordinate health and safety oversight of operations aboard the vessel. The vessel operator will also have stop work authority for safety reasons. Work will be resumed after the vessel operator and the Field Supervisor agree that the situation that precipitated a stop work decision has been corrected.

Field Crew: All field crew have the responsibility to report any potentially unsafe or hazardous conditions to the vessel operator or Field Supervisor immediately.

Communications: Dr. Keith will keep the Project Coordinator informed of work schedules and follow up on incidents that may occur during the work. The Field Supervisor will have the following responsibilities:

- Contacting Dr. Keith and the appropriate person at each facility on a daily basis to inform them of schedule, planned work areas, and access issues (facility points of contact are provided in Attachment A).
- Contacting the appropriate person at each facility in the event of a facility emergency or release as described in Section 4.1.7 below.
- Reporting any accident that involves bodily injury or damage to equipment to all facility contacts, the JDG representatives, and Dr. Keith immediately. An accident will be reported no matter how small or insignificant it may seem at the time, and no matter where on the Site it occurs.
- Coordinating initial facility training for field crews.
- Ensuring field crew are current with safety training and that annual updates are completed.

4 HAZARD EVALUATION AND CONTROL MEASURES

This section covers potential physical and chemical hazards that may be associated with the proposed project activities, and presents control measures for addressing these hazards. The activity hazard analysis, Section 4.3, lists the potential hazards associated with each Site activity and the recommended site control to be used to minimize each potential hazard. Confined space entries are not expected at this time, so hazards associated with this activity are not discussed in this HASP. If this activity is required, an addendum to the HASP will be developed and submitted for review.

4.1 Physical Hazards

4.1.1 Slips, Trips, and Falls

As with all fieldwork sites, caution should be exercised to prevent slips on slick surfaces. In particular, sampling from a floating platform requires careful attention to minimize the risk of falling down or falling overboard. The same care should be used in rainy conditions. Wearing boots with good tread, made of material that does not become overly slippery when wet can minimize slips.

Trips are always a hazard on the uneven deck of a boat or in a cluttered work area. The deck of the vessel will have moving cables, and there are numerous stationary fittings and ties-downs that present potential tripping hazards. Personnel will keep work areas as free as possible from items that interfere with walking and will be aware of stationary obstacles on deck.

Falls may be avoided by working as far away from exposed edges as possible. For this project, the potential for falling is associated primarily with deployment and recovery of the sampling equipment over the side of the vessel and with boarding and disembarking the vessel at the dock or shore. Workers should not enter the Bayou unless access is provided through a boat or sampling platform.

4.1.2 Boating Hazards/Water Safety

The vessel operator is responsible for the safety and security of all personnel and equipment aboard the vessel. The vessel operator will be the individual to decide if conditions are favorable to conduct any or all related operations requiring the services of

the specific vessel and crew. If any vessels operate around or near the pipeline crossing at the mouth of the Bayou, appropriate security clearance from the United States Coast Guard will be obtained prior to any work in that area.

4.1.2.1 Before Launching

Before launching, field staff will do the following:

1. The Field Supervisor will contact each facility representative to obtain access to the Bayou and ensure each facility is aware of the anticipated field operations for the day. Field Supervisor will also be responsible for checking in with each facility upon completion of work.
2. The Field Supervisor will hold a daily briefing reviewing the work to be completed each day, each worker's responsibilities, and any potential new risks or observations from prior day's work efforts.
3. Supervisors/Vessel Operators shall verify that the forecasted weather and sea conditions are appropriate for safe boat operation.
4. Supervisors shall verify that equipment operators are capable and qualified to operate each type of equipment before allowing the equipment to be operated unsupervised.
5. Equipment operators shall perform a pre-operational check of their equipment. They will be familiar with the operator's manual, report needed repairs promptly, and will not use any equipment that is unsafe.
6. Provide an approved personal flotation device (PFD) in good condition for each occupant. If the vessel is 16 feet or more in length, one throwable Type IV PFD device will also be on board the vessel.
7. Ensure that the boat is equipped with a properly charged fire extinguisher, first aid box, boat hooks, paddles, and mooring lines.
8. Brief new personnel on safety equipment use and location.
9. Make sure drain plugs are in place.
10. Ensure that there is sufficient fuel on board for the trip.
11. Be sure that the bowline is attached to the bow and secured before backing down launch ramp.
12. When applicable, make radio check with shore facility when working from boat.

13. Make a visual check of hull for rips, tears, or holes.
14. Check engine oil and drive oil levels.
15. Prior to departure, the vessel operator shall perform a daily inspection to ensure all required safety equipment is onboard and functional.

4.1.2.2 After Launching

While the boat is in operation, field crew will observe the following guidelines:

1. When fueling, extinguish all open flames and avoid overflow.
2. Check for water leakage from hull or engine.
3. Observe maritime "Rules of the Road."
4. Before getting underway, be sure that everyone is familiar with boat, their machinery, and its operation.
5. Remain seated while underway. One person moving around in a small boat has tremendous effect on the boat's stability.
6. Remember to distribute the load evenly; keep load low, do not stand up in a small boat and do not overload.
7. Monitor local marine weather radio for changing conditions when operating on open water.
8. Anticipate problems of safety when small craft warnings are signaled or broadcast.
9. Always obey orders from state, local, or federal marine patrolmen.
10. In case of a fire while underway, attempt to put it out before abandoning ship. For engine fires turn off the engine and shut off the fuel supply. Use the fire extinguisher by pointing at the base of the flame.
11. If a crew member goes overboard, the vessel operator should:
    - Maneuver the stern away from the side the person went over so as to ensure that he or she clears propellers safely.
    - Maintain visual contact with the person at all times. This is probably the single most important factor in saving someone who has gone overboard.
    - Maneuver boat at a slow speed alongside the person overboard and put engine in "neutral."

- If other personnel are aboard, the vessel operator is to remain at the helm and let other personnel retrieve the person overboard. If alone, the vessel operator should perform the retrieval.

4.1.2.3 Boat Retrieval

To retrieve the boat from the water:

1. Back up to trailer with assistance of another person.
2. Check condition of hitch, safety chain, electrical lines, winch, and winch cable.
3. Make sure winch is in locked position before moving trailer and boat.
4. Check for proper alignment of boat on rollers and V-block.
5. Check condition of trailer wheels and brakes.
6. Be sure boat is secure before moving.
7. Sampling boats shall be removed from the water and put on a trailer to be taken to an upland storage area when a hurricane or especially severe weather is anticipated.

4.1.2.4 Boat Towing

When towing the boat from the Site:

1. The Field Supervisor shall discern if the individual who is towing the boat has sufficient skills and knowledge to operate the vehicle pulling the referenced vessel and trailer. No one shall tow a vessel without sufficient experience.
2. Check to ensure all trailer lights are functional before departing.
3. Maintain posted highway speed limits for towed vehicles.
4. Ensure that the proper braking distance in maintained from the vehicle in front of the towed rig.

4.1.3 Manual Lifting

Equipment must be lifted and carried both aboard the vessel and on shore. Back strain can result if lifting is done improperly. During any manual handling tasks, personnel should lift with the load supported by their legs and not their backs. For heavy loads, an

adequate number of people will be used, or if possible, a mechanical lifting/handling device.

4.1.4 Heat Stress and Heat Exhaustion

Some of the scheduled sampling operations will be occurring from August though October, and high work environment temperatures will be encountered. The potential for heat stress and heat exhaustion may occur if impermeable personal protective equipment (PPE) is worn or if strenuous work is performed under hot conditions with inadequate water. When the core body temperature rises above 100.4°F, the body cannot sweat sufficiently to cool down, and heat stress and/or heat exhaustion can occur. Heat stress may be identified by the following symptoms: dizziness, profuse sweating, skin color change, vision problems, confusion, nausea, fatigue, fainting, and clammy skin. Heat exhaustion is also a result of excessive heat and dehydration, and can also be identified by signs including paleness, dizziness, nausea, vomiting, fainting, and a moderately increased body temperature. Personnel exhibiting such symptoms will be removed to a cool shady area, given water, and allowed to rest. Fresh drinking water will be provided in a clean, safe area aboard the vessel. All field team members will monitor their own condition and that of their co-workers to detect signs of heat stress and heat exhaustion. Water breaks and a work/rest schedule will be instituted if either of these becomes a recurrent problem.

4.1.5 Hypothermia

Sampling and field activities may occur during the winter season and cool to cold air temperatures are likely to be encountered during this time frame. Hypothermia is possible if inadequate clothing or inadvertent immersion in water occurs. Hypothermia is abnormal lowering of the core body temperature caused by exposure to a cold environment. Windchill as well as wetness or water immersion can play a significant role. Typical signs of hypothermia include fatigue, weakness, and lack of coordination, apathy, and drowsiness. Confusion is a key symptom of hypothermia. Shivering and pallor are usually absent, and the face may appear puffy and pink.

Body temperatures below 90°F require immediate treatment to restore the temperature to normal. Current medical practice recommends slow warming of the individual

followed by professional medical care. Moving the person to a sheltered area and wrapping them in blanket can accomplish this portion of the task. If possible, the person should be placed in a warm room. In emergency situations where body temperature falls below 90°F and shelter is not available, a sleeping bag, blankets, and body heat from another individual can be used to help raise body temperature.

4.1.6 Weather

In general, field team members will be equipped for the normal range of weather conditions. The Field Supervisor will be aware of current weather conditions, and of the potential for those conditions to pose a hazard to the field crew. Some conditions that might force work stoppage are electrical storms, high winds, or high waves resulting from winds.

4.1.7 Facility Equipment and Hazards

Each of the industrial facilities that is adjacent to the Bayou actively produces chemical and/or petroleum products. These types of production facilities have inherent risks associated with planned and unplanned releases of hazardous chemicals to the environment, explosions, and fire. If a release or a hazardous event occurs at a facility, alarms and instructions for evacuation will be broadcast. Workers in the area should follow instructions provided over the broadcast, and specific instructions given in facility-specific safety training. In all cases, evacuation of an area should be through the shortest route possible that does not involve egress through a hazardous chemical plume. Wind direction should be checked using wind socks at each facility so that evacuation paths are perpendicular to the prevailing wind direction and downwind areas are avoided. The facility POC (Section 1) should be notified as soon as practical to inform them of the field crew status after any facility-wide emergencies and/or evacuations.

Two known areas of safety concern occur within or near the Site. Those are the East Property Flare (EPF) at the Shell facility and sulfur drains at Lubrizol. The EPF may have heat and noise issues during the event of serious flaring; hydrocarbons and fire have been discharged to the Bayou and surrounding land in the past. Releases from the

EPF are unscheduled. If a release occurs from the EPF during the field work, the area should be evacuated immediately.

The sulfur drain at Lubrizol is a scheduled event that can release hydrogen sulfide and mercaptans to the local area on the northwest side of the Lubrizol property. The Field Supervisor will be notified of any scheduled release from the sulfur drain at Lubrizol during the daily facility representative phone briefing.

If a hazardous condition arises as a result of the industrial facilities operations, the area should be evacuated and the facility contact notified by the Field Supervisor.

4.2 Chemical Hazards

Based on the nature of the work to be performed at this Site, exposure to chemical hazards is not expected, but may potentially occur. Identified chemicals of potential concern (COPCs) are metals, organotins, polycyclic aromatic hydrocarbons (PAHs), pesticides, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), and total sulfides. In addition, there is potential for exposure to hydrogen sulfide gas release from the sulfur drain at Lubrizol.

4.2.1 Exposure Routes

Potential routes of chemical exposure include inhalation, dermal contact, and ingestion. Providing personnel with appropriate training, using safe work practices, and wearing the appropriate PPE will minimize exposure. Further discussion of PPE requirements is presented in Section 7.

4.2.1.1 Inhalation

Because wet sediments do not generate dust particles, and surface water spray is expected to be minimal, inhalation of particulates is not expected to be an important route of exposure concern. Potential exposure via inhalation of hydrogen sulfide gas emitted from sediments is possible. However, sediment disturbance is expected to be minimal, if any, and would occur outside, reducing the risk of inhalation exposure. Lubrizol and Shell production facilities both present potential hazards related to hydrogen sulfide gas releases.

Dust generated during upland activities is expected to be minimal and there are no known contaminants in upland soils at this Site; however, arsenic and barium are naturally present in the Site soils at above normal concentrations.

4.2.1.2 *Skin Contact*

Dermal exposure to potentially contaminated sediments, surface water, or equipment will be avoided or will be controlled by the use of PPE if necessary.

4.2.1.3 *Ingestion*

Ingestion is not considered a major route of exposure for this project. However, eating, drinking, chewing gum or tobacco, smoking, or any action that increases the probability of ingestion of material is prohibited in active work areas and throughout each of the four facilities.

4.2.2 Description of Chemical Hazards

4.2.2.1 *Metals*

Exposure to metals may occur via ingestion or skin contact. As mentioned above, neither is likely as an exposure route. It is not expected that metal fumes or metal-contaminated dust will be encountered during field and sample handling activities. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for passage of any of the metals into the body. Field procedures require immediate washing of sediments from exposed skin. Plastic jugs of distilled water will be used for wash and rinse.

4.2.2.2 *Polycyclic Aromatic Hydrocarbons*

Because PAHs are relatively nonvolatile, respiratory hazards are expected to occur only under dusty and windy conditions. However, sediment contact with the skin and eyes can cause irritation and burning.

4.2.2.3 *Polychlorinated Biphenyls*

Prolonged skin contact with PCBs may cause acne-like symptoms known as chloracne. Irritation to eyes, nose, and throat may also occur. Acute and chronic

exposure can damage the liver, and cause symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. PCBs are a suspected human carcinogen. Skin absorption may substantially contribute to the uptake of PCBs.

4.2.2.4 Hydrogen Sulfide

A result of chemical and petroleum production facilities adjacent to the Bayou and naturally occurring conditions in sediments, hydrogen sulfide gas is potentially toxic via inhalation, ingestion, and skin and eye contact. Inhalation can result in respiratory irritation, rhinitis, and edema of the lungs. Subacute exposures to hydrogen sulfide may result in headache, dizziness, staggering gait, and agitation. Acute exposure at higher concentrations may result in immediate coma and possibly death as a consequence of respiratory failure. Monitoring requirements for hydrogen sulfide are provided in Section 8.2.

4.2.2.5 Chlorine Gas

Although chlorine gas is not a site-related contaminant expected to be encountered during Site activities, releases of chlorine gas from processes at the adjacent facilities are possible. Exposure to chlorine gas may occur via inhalation or skin contact. In sufficient concentration, the gas irritates the mucous membranes, the respiratory tract, and the eyes. Chlorine inhalation may cause coughing, nausea, vomiting, headache, dizziness, and difficulty breathing. It may also cause pulmonary edema (build-up of fluid in the lungs), which may be delayed by several hours and can be fatal. Chlorine hydrolyzes very rapidly yielding hydrochloric acid so skin burns are like that from exposure to hydrochloric acid. Chronic (long-term) exposure to chlorine gas can result in respiratory effects, including eye and throat irritation and airflow obstruction.

4.2.3 Description of Biological Hazards

Biological hazards that may be present in the project area are those associated with marine estuaries and land/grassy environments. They include aquatic and terrestrial animals (such as snakes, alligators, and stingrays), insects, poisonous plants, and bacteria/parasites that may be present in waters, sediment/soil, and shellfish.

To minimize contact with potential biological and parasitic hazards, all work on water should be performed from boats or other suitable platforms. Under no circumstances other than rescue efforts should personnel wade into shallow waters. Skin contact with water and sediment/soil will be avoided.

4.2.3.1 Snakes

To prevent snakebite, employees should:

- Wear work boots and long pants. Snake chaps and snake bite kits are to be standard equipment when working in areas suspected to be inhabited by poisonous snakes.
- Make as much noise as possible when approaching a possible snake area (this includes most areas of the Site) to give snakes time to leave.
- Be equipped with a bush axe for clearing underbrush.
- Avoid reaching or stepping into heavily covered areas whenever possible.

If a snakebite should occur, the affected employee should:

- Remain as calm as possible.
- Move away from the snake.
- Apply a constricting bandage (not tourniquet) between the wound and heart. A finger should be able to pass under it. Apply ice to bite area, if available.
- Have a fellow worker to transport him/her to closest medical facility.
- If possible, kill snake and carry to medical facility for identification.

Under no circumstances should incisions and suction be used to treat a snakebite unless:

- The victim is over 1.5 hours from medical assistance, and
- The person administering first aid has received advanced training in medical assistance such as First Responder, EMT, etc.

4.2.3.2 Insect Bites/Stings

To avoid insect bites and stings, employees should:

- Alert their co-workers if they have a known allergy to particular insect bites/stings.
- Wear appropriate clothing such as long pants, sleeves, and hats.

- Avoid areas with saturated ground or standing water where insects might be whenever possible.
- If possible, schedule work in infested areas during the cool months.
- Avoid strong smelling after-shaves, colognes, etc., that may attract insects.
- Use available insect repellents.
- If a sting does occur, any stinger should be removed with a knife blade or fingernail. The area should then be treated with hydrocortisone.
- Check first aid kit for treatment.

4.2.3.3 Ticks

Ticks are especially dangerous because of the possibility of Rocky Mountain Spotted Fever or Lyme Disease. To minimize exposure, employees should follow these guidelines:

- Wear appropriate clothing when working in wooded areas.
- Use a tick repellent with DEET as a primary ingredient.
- Check yourself at least twice a day, paying particular attention to the hair, neck, and groin area.
- To remove an attached tick, cover it with heavy oil (mineral, salad, or machine) to close its breathing pores. The tick may disengage at once; if not, allow the oil to remain in place for a half hour. Then carefully remove the tick with tweezers, taking care that all parts are removed. If possible, retain engorged ticks and place in a container for identification of the tick type.
- With soap and water, thoroughly, but gently scrub the area from which the tick has been removed, because disease germs may be present on the skin.
- Call a doctor if fever, chills, headaches, or muscle aches develop within 3 to 10 days after exposure. In some cases, a rash may develop on the wrists and ankles 1 to 3 days after the fever begins.

4.2.3.4 Poisonous Plants

An employee can have exposure to at least three types of poisonous plants at the Site: poison oak, poison ivy, and poison sumac. Reactions can range from mild (very little or none) to severe (rash and blisters). Employees who have no reaction may not have become sensitized, but once they are, future exposures can result in an allergic reaction.

To avoid problems with poisonous plants, employees should:

- Learn to identify poisonous plants and avoid working in severely infested areas if at all possible.
- Wear long sleeve shirts, long pants, and work gloves. If performing clearing activities with either hand (e.g., bush axes, machetes, etc.) or power tools, use eye goggles/safety glasses to prevent poisonous plant particles or residues from entering eyes.
- Use silicone protective or other barrier creams where available.
- Use TECNU Poison Ivy Wash on any place that may have been exposed. In some cases, this can even be effective 24 hours after exposure.
- Be sure that any clothes or shoes that may have been exposed are thoroughly washed. Leftover oils on anything could cause a reaction even days later.
- If a severe reaction develops, contact a doctor for possible treatments.
- Avoid rubbing your eyes if you have been in contact with poisonous plants.

4.2.3.5 Waterborne Pathogens

A potentially life-threatening bacterium, *Vibrio vulnificus*, occurs naturally in estuarine and marine waters and in associated filter-feeding shellfish, such as oysters and mussels. The organism is able to cause infection though ingestion or through a wound. *Vibrio vulnificus* is common in Texas coastal waters from May to September (when waters are the warmest). Most healthy people are resistant to infection with this bacterium. Those who are at risk are persons with underlying diseases (especially liver diseases), blood disorders, diabetes, cancer, or any condition that affects the immune system. Persons considered to be at risk for bacterial infections shall not perform field tasks associated with this project.

The symptoms of developing a *Vibrio vulnificus* infection include, but may not be limited to:

- Fever and chills
- Redness and swelling of affected area
- Pain
- Decreased blood pressure
- Tissue destruction at the site of the wound

Persons developing a *Vibrio vulnificus* infection require immediate medical attention including antibiotics, and potentially the removal of affected tissue or limbs. To reduce the possibility of *Vibrio vulnificus* or any other infection during field activities, care shall be taken not to allow any exposure of cuts or abrasions to the waters of the project area or the equipment or samples that have been in contact with the waters. Any cuts or abrasions that occur while performing the sampling activities shall be immediately treated with a topical antibacterial agent and bandaged. Should the affected area exhibit redness, swelling, or any other abnormal symptom, immediate medical attention should be sought.

Potential parasitic hazards may be present in surface waters, sediment, and soil. These include, but are not limited to: roundworm, whipworm, and hookworm. People can become infected with intestinal worms through contact with soil that has been contaminated with human or animal feces. Parasites can enter the body through ingestion, as well as dermal contact. Hookworm larvae, which may be present in animal feces (including nutria [*Myocastor coypus*] feces), can burrow through skin. Intestinal parasites can cause symptoms such as:

- Diarrhea
- Abdominal cramps
- Loss of appetite
- Distended abdomen
- Coughing, fever, and vomiting

Anyone experiencing these or any abnormal symptoms should seek medical attention. To reduce the potential for exposure to parasites, skin contact with water and sediment/soil will be avoided through the use of rubber gloves, or any other appropriate PPE.

4.3 Activity Hazard Analysis

The activity hazard analysis summarizes the field activities to be performed, outlines the hazards associated with each activity, and presents controls that can reduce or eliminate the

risk of the hazard occurring. Table 4-1 presents the activity hazard analysis for the following activities:

- Collecting surface water, surface sediment grabs, and manually driven sediment cores from a sampling vessel
- Installing water quality monitoring equipment

The activity hazard analysis will be reviewed and updated if needed prior to any field activities performed under the Patrick Bayou Superfund Site RI/FS, including those Work Plan activities described previously. This review will ensure that hazards are properly identified and adequate controls are described prior to field activities being performed.

Table 4-1
Activity Hazard Analysis

Activity	Hazard	Control
Collecting surface water, sediment grabs, and manually driven sediment cores from a sampling vessel	Falling overboard	Avoid working near the edge of the vessel, if possible. Stay inside of perimeter barriers on the deck.
	Slipping or tripping on slick or uneven deck	Wear steel-toed boots with gripping tread. Be aware of obstacles and wet patches on the deck and select a path to avoid them.
	Fire	Avoid fueling operations near hot engines. Mop up any spilled flammable liquids and dispose of absorbent material. No smoking or flame sources will be allowed on the vessel. Evacuate the vessel according to procedures outlined in the training session given by the vessel operator.
	Back or muscle strain	Use appropriate lifting technique. Seek help for weights over 50 pounds or awkward lifting.
	Skin or eye contact with potentially contaminated sediments or liquids	Wear modified Level D PPE, including eye protection.
	Contact with water-borne pathogens	Wear modified Level D PPE.
	Heat stress and/or heat exhaustion	Monitoring of personnel and maintenance of adequate hydration; addition of work/rest schedules if needed.
Deploying water quality meters from sampling vessel	Falling overboard	Avoid working near the edge of the vessel, if possible. Stay inside of perimeter barriers on the deck.
	Slipping or tripping on slick or uneven deck	Wear steel-toed boots with gripping tread. Be aware of obstacles and wet patches on the deck and select a path to avoid them.
	Fire	Avoid fueling operations near hot engines. Mop up any spilled flammable liquids and dispose of absorbent material. No smoking or flame sources will be allowed on the vessel. Evacuate the vessel according to procedures outlined in the training session given by the vessel operator.
	Contact with water-borne pathogens	Wear modified Level D PPE
	Heat stress and/or heat exhaustion	Monitoring of personnel and maintenance of adequate hydration; addition of work/rest schedules if needed.

5 WORK ZONES AND ACCESS CONTROL

This section is designed to reduce the spread of hazardous substances from contaminated areas to clean areas, to identify and isolate contaminated areas of the Site, to facilitate emergency evacuation and medical care, to prevent unauthorized entry to the Site, and to deter vandalism and theft [in compliance with 29 CFR 1910.120(b)(4)(ii)(F) and 29 CFR 1910.120(d)].

Three work areas will be established during sampling activities:

- The exclusion zone is the area where a hazardous substance is known or suspected to be present and poses the greatest potential for exposure. Only authorized field personnel in the appropriate PPE will be allowed in the exclusion zone.
- The contamination reduction zone (CRZ) is the transition area between the contaminated area (i.e., the exclusion zone) and the clean area (i.e., the support zone).
- The support zone is the area where all personnel will suit-up in specified PPE before entering the CRZ or exclusion zone. The support zone includes storage areas for clean equipment and resting and eating facilities for personnel.

The Site will be monitored for changing conditions that may warrant adjustment of zone boundaries. Zone boundaries will be adjusted as necessary to protect personnel and clean areas. Whenever boundaries are adjusted, zone markings will also be changed and workers will be immediately notified of the change.

The Field Supervisor is responsible for evaluating Site conditions and for verifying that Site controls function effectively. This section may be updated regularly to reflect current Site conditions, work operations, and procedures. The site-specific site control zones for sediment sampling tasks are described below.

5.1 Exclusion Zones

Exclusion zones will be established wherever exposed Bayou sediment is handled.

5.1.1 Sampling Vessel

During intrusive sampling on a sampling vessel, the exclusion zone includes the area of the vessel in which sediments collected from the Bayou bottom are handled. For small sampling vessels (less than 20 feet), the entire vessel will be considered the exclusion

zone. The exclusion zone boundaries will be marked with yellow or black adhesive tape (OSHA 1910.144) on the deck floor. This part of the vessel is designated as the exclusion zone only when sediment samples are being handled on the vessel.

5.1.2 Field Laboratory

Onshore facilities will be utilized for all sediment core processing activities, including a mobile facility that may be used for surface sediment sample processing. Each sediment processing facility will identify a clearly marked exclusion zone where all sediment handing will occur. The exclusion zone boundaries will be marked with yellow caution tape, or yellow or black adhesive tape (OSHA 1910.144).

5.2 Contamination Reduction Zone

For surface sediment and core processing, the CRZ will consist of an area surrounding the exclusion zone where decontamination of both personnel and equipment will occur. If the size of the vessel allows, as determined by the Field Supervisor or designee, the CRZ will be defined as the vessel deck during on-water sediment handling, except as noted in the preceding paragraph. Decontamination of both personnel and equipment will occur in the CRZ to prevent the transfer of COCs to the support zone.

5.3 Support Zone

If the size of the vessel allows (as determined by the Field Supervisor or designee), the support zone will be located in the cabin of the vessel or on the vessel deck when contaminated sediments are not on deck.

6 SAFE WORK PRACTICES

Following common sense rules will minimize the risk of exposure or accidents at a work site. These general safety rules will be followed on Site:

- Prior to initiating a work task, each worker should perform a brief assessment of the task, evaluating how to safely perform the task
- Always use the buddy system
- Be aware of overhead and underfoot hazards at all times
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zones
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries
- Report all accidents, no matter how minor, to the Field Supervisor, and the Field Supervisor will notify the PM and Facility POC
- Be alert to your own and other workers' physical condition
- Do not climb over or under obstacles of questionable stability
- Make eye contact with equipment operators before moving into the range of their equipment
- Work during daylight hours

7 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

Appropriate PPE will be worn as protection against potential hazards. In addition, a PFD will be required when working on the vessel. If the vessel is 16 feet or greater in length, a Type IV throwable PFD will be on board. Prior to donning PPE, the workers will inspect their equipment for any defects that might render the equipment ineffective.

Fieldwork will be conducted in Level D or modified Level D PPE, as discussed below in Sections 7.1 and 7.2. Situations requiring PPE beyond modified Level D are not anticipated for this project. Should the Field Supervisor determine that PPE beyond modified Level D is necessary at a given location, the Field Supervisor will notify the HSM to select an alternative.

7.1 Level D Personal Protective Equipment

Workers performing general activities in which skin contact with contaminated materials is unlikely and in which inhalation risks are not expected will wear Level D PPE. Level D PPE includes the following:

- Chemical-resistant steel-toed boots
- Leather, cotton, or chemical-resistant gloves, as the type of work requires
- Safety glasses
- Hard hat (if overhead hazard exists)
- Coveralls or other appropriate clothing (long pants and long-sleeved shirt)
- Hearing protection, if necessary

7.2 Modified Level D Personal Protective Equipment

Workers performing activities where skin contact with contaminated materials is possible will wear chemical-resistant outer gloves and an impermeable outer suit. The type of outerwear will be chosen according to the types of chemical contaminants that might be encountered. Modified Level D PPE includes the following:

- Outer garb such as rain gear or rubber or vinyl aprons
- Chemical-resistant steel-toed boots
- Surgical rubber inner gloves
- Chemical-resistant outer gloves
- Safety glasses (or face shield, if significant splash hazard exists)
- Hard hat (if overhead hazard exists)

- Hearing protection, if necessary

7.3 Safety Equipment

In addition to PPE that will be worn by personnel, basic emergency and first aid equipment will also be provided. Equipment will include:

- A copy of this HASP (including a laminated copy of the hospital route and emergency contact numbers on the back)
- PFD (plus a Type IV throwable PFD if vessel is 16 feet or more in length)
- First aid kit adequate for the number of personnel
- Snakebite kit and insect repellent
- Hydrogen sulfide monitors, if working in the gunite-lined channel
- Gas mask with canister or mount-piece respirator with chlorine cartridges for emergency escape if working in the gunite-lined channel. This area extends primarily along the reach bounded by the Lubrizol facility from Highway 225 to the downstream end of the gunite-lined channel (Figure 8-1).

With the exception of the HASP, Anchor and its subcontractors will provide their own personnel with this equipment, which must be at the location(s) where field activities are being performed. The HASP will be provided to all subcontractors scheduled to perform work at the site prior to beginning work. Anchor will provide copies of the HASP to its own staff members involved with field operations associated with the RI/FS. Equipment will be checked daily to ensure its readiness for use.

8 MONITORING PROCEDURES FOR SITE ACTIVITIES

A monitoring program that addresses the potential site hazards will be maintained. For this project, dust monitoring will not be necessary; however, air monitoring for potential hydrogen sulfide release is required. Monitoring procedures will include crew self-monitoring, buddy system monitoring, facility emergency monitoring, and hydrogen sulfide monitoring.

All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental condition during the performance of all field activities. If any of these conditions develop, the affected person(s) will be moved from the work location and treated. Personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious.

If any accidents, injuries, or other deleterious changes to any person's physical well-being occur, all work will stop. The Field Supervisor will immediately notify the PM and the facility POCs (Section 1). The Field Supervisor, the PM, the JDG representatives, and the facility POCs will jointly determine if any corrective actions need to be undertaken prior to restarting any additional work.

8.1 Crew Self Monitoring

All personnel will be instructed to look for and inform each other of any deleterious changes in their or others physical or mental condition during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern

- Symptoms of heat stress or heat exhaustion, see Section 4.1.4
- Symptoms of hypothermia, see Section 4.1.5

If any of these conditions develop, the affected person(s) will be moved from the work location and treated. Personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious.

If any accidents, injuries, or other deleterious changes to any person's physical well-being occur, all work will stop. The Field Supervisor will immediately notify the PM and the facility POCs. The Field Supervisor, the PM, and facility POCs will jointly determine if any corrective actions need to be undertaken prior to restarting work.

8.2 Facility Emergency Monitoring

Releases or other hazardous events that could affect conditions at the Site could occur at adjacent facilities during site investigations. Each facility has release monitoring and response procedures. If a release (e.g. chlorine gas) or other hazardous event occurs at a facility, alarms and instructions for evacuation will be broadcast. Workers in the area should follow instructions provided over the broadcast, and specific instructions given in facility-specific safety training (see Section 4.1.7). In all cases, evacuation of an area should be through the shortest route possible that does not involve egress through a hazardous chemical plume.

8.3 Air Monitoring

Each sampling team will be provided with a continuous personal hydrogen sulfide air monitor when work is occurring. This monitor should be turned on at all times while work is being performed in the area of Patrick Bayou identified in Figure 8-1. This area extends primarily along the reach bounded by the Lubrizol facility from Highway 225 to the downstream end of the gunite channel.

The Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (Ceiling concentration) for hydrogen sulfide is 20 parts per million (ppm) with a 50 ppm acceptable maximum peak (10 minute duration) (29 CFR 1910.1000 TABLE Z-2). An audible signal will be emitted by the monitor if hydrogen sulfide levels exceed a warning level of 10

ppm and an action level of 15 ppm. If the signal on a monitor is activated above the action level of 15 ppm, all members of the crew will immediately evacuate the required hydrogen sulfide monitoring area. If more than one team is in the required monitoring zone, all teams will leave the area immediately. Enough monitors will be available so that each team working in the required monitoring area has one monitor with at least one extra monitor at the Site available as a back up should the primary monitors become inoperable. The Field Supervisor will identify the member of each team to wear the monitor. The personal monitor must be worn and activated at all times in the required hydrogen sulfide monitoring area and should be worn in such a way as to measure concentrations within the breathing zone. The evacuation route should be perpendicular to wind away from any potential hydrogen sulfide sources. Each facility has wind socks to provide wind direction. Prior to work in this area, each member of the crew will be required to locate the wind sock and determine the wind direction. The Field Supervisor, PM, and facility POCs should be notified of any hydrogen sulfide emissions as soon as practical.

All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental condition during the performance of all field activities that can result from hydrogen sulfide exposure. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern

If any of these conditions develop, the affected person(s) will be moved from the work location and treated. Personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious.

8.3.1 Hydrogen Sulfide Monitor Requirements

Hydrogen sulfide monitoring detectors use for personal monitoring will meet or exceed the following:

- Portable battery-powered hydrogen sulfide detector equipped with a triple-alarm system (LED display, audible alarm, and vibrating alarm) to ensure that alarm conditions are recognized
- Detectors will automatically record alarm events, and can be downloaded for documentation of exposure levels should an unplanned release of hydrogen sulfide be encountered during sampling
- Estimated 2-year battery and sensor life for the detector under normal operating conditions.

8.3.1.1 Calibration and Instrument Circuit Checks

Instrument calibration or performance tests, as required by the manufacturer, will be documented and included in a dedicated Health and Safety logbook or on separate instrument check pages. All instruments shall be tested or calibrated, as required, before and after each shift. Additional checks or calibrations may be performed during the day to confirm instrument response at the discretion of the Field Supervisor.

8.3.1.2 Operations

All instruments shall be operated in accordance with the manufacturer's specifications. Manufacturer's literature, including an operations manual for each piece of air monitoring equipment shall be maintained on-site by the Field Supervisor for reference.

8.3.1.3 Data Review

The Field Supervisor shall review the monitoring and sampling data, along with all sample documentation, with the HSM to evaluate the potential for worker exposure and upgrades or downgrades in levels of protection. Periodically, personnel exposure results shall be discussed at the daily safety briefing.

8.4 Monitoring Records

The PM must ensure that site-monitoring records are complete and incorporated into the project file. The Field Supervisor is responsible for establishing, maintaining, and forwarding all required monitoring information, as described below:

- Employee name
- The date, time, pertinent task information, exposure information
- Description of the analytical methods, equipment used, and ancillary data
- Type of PPE worn
- Engineering controls used to reduce exposure.

8.5 Medical Monitoring

Anchor will utilize the services of physicians who are board certified in occupational medicine to supervise the medical surveillance program. The medical examination will consist of:

- Medical history
- General physical, including evaluation of all major organ systems
- Pulmonary function examination (at least FVC and FEV 1.0)
- Electrocardiogram
- Stress test (optional physician's discretion)
- Chest X-ray (baseline, one scheduled every 10 years, or upon leaving Anchor's employment)
- Otoscopic examination
- Audiometric examination
- Visual acuity examination
- Blood tests, blood count, blood profile – (SMAC 25)

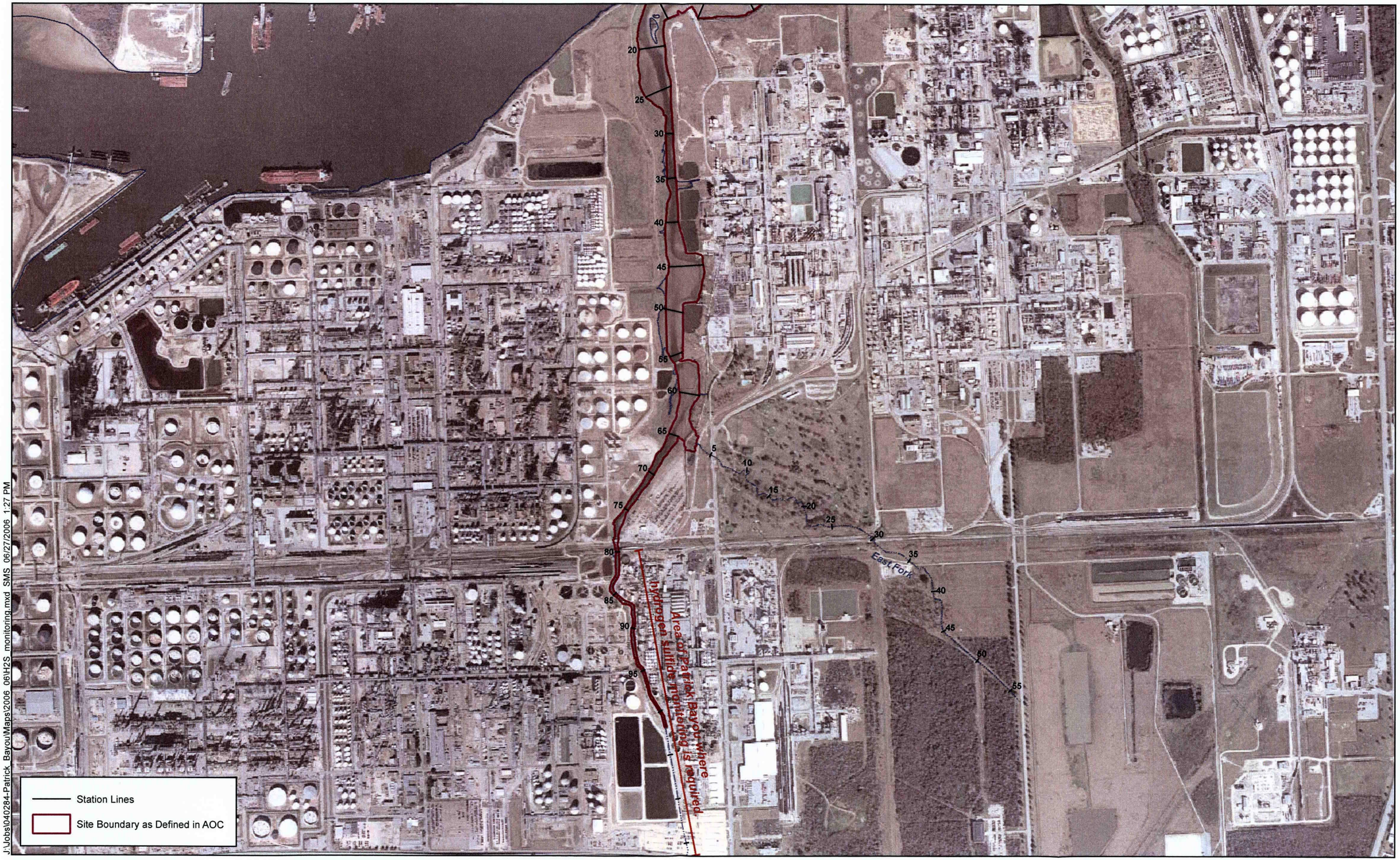
A baseline examination will be given prior to the start of work activities. Medical examinations will be repeated in the following conditions:

- More than a year has passed since the employee's last examination.
- The employee experiences an acute exposure to a toxic, hazardous material, or an injury.
- The examining physician, the PM, HSM, or Field Supervisor recommends one.

- At the request of an employee with demonstrated symptoms of exposure to toxic or hazardous materials.

Anchor will obtain a certification from the occupational physician that the employee is medically fit to wear respiratory protection and has no medical condition that would place the individual at an increased risk. No employee will be permitted to work in the exclusion zone until the certificate has been submitted. If any employee who works in the exclusion zone or CRZ is taking prescription medicines, this information will be transmitted to the consulting occupational health physician who will make a determination whether this drug enhances the effect of the contaminants present on site.

All medical records will be kept for at least 30 years and will be made available to the PM or regulatory agencies, as required.



ANCHOR ENVIRONMENTAL, L.L.C.

0 500 1,000 2,000
Scale in Feet

Stations are placed in 500-foot intervals. Station numbers indicate length along channel in hundreds of feet.
Aerial orthoimagery from USGS, June 2002.

Figure 8-1
Required Hydrogen Sulfide Monitoring Locations
Patrick Bayou RI Work Plan

9 DECONTAMINATION

Any equipment that comes in contact with sediment (including, but not limited to, sediment probes, piston cores, the van Veen grab sampler, skiffs, and field equipment), will be decontaminated per the decontamination requirements prescribed in the Quality Assurance Project Plan (QAPP). Large equipment (e.g., vessels and trailers) will be decontaminated at the OxyVinyls groundwater stripper diked Area. This area is part of the decommissioned mercury cell plant. Jeff Adamski (OxyVinyls facility) will coordinate proper disposal of decontamination solid waste. Each piece of large equipment will be rinsed down with a hose in the Brine Saturator Dike Area until all loose particulate material is removed. All rinsate will be contained in the Dike Area. Field decontamination wastes for smaller equipment and PPE will be collected at the field decontamination area and transported to the OxyVinyls Brine Saturator Dike Area for disposal.

Personnel decontamination may be required if contact with sediment or water occurs. The following are general decontamination procedures established and implemented at the Site:

- Decontamination is required for all workers exiting a contaminated area. Personnel may re-enter the support zone after undergoing the decontamination procedures described in this section.
- Protective clothing will be decontaminated, cleaned, laundered, maintained, or replaced as needed to ensure its effectiveness.
- PPE used at this Site that requires maintenance or parts replacement will be decontaminated prior to repairs or service.
- PPE used at this site (e.g., gloves) will be decontaminated or prepared for proper disposal.
- If a worker's permeable clothing is splashed or becomes wetted with a hazardous substance, they will immediately exit the work zone, perform applicable decontamination procedures, and change into uncontaminated clothing.
- Procedures used on the Site for disposal of decontamination waste will meet applicable local, state, and federal regulations.

It is emphasized that skin washing is one of the easiest ways to reduce incidental ingestion and skin absorption of chemicals. All exposed skin, including hands, arms, face, and neck, should

be washed frequently and thoroughly throughout the work day and always before eating, drinking, or smoking.

In case of an emergency, gross decontamination procedures will be rapidly implemented, if possible. If a life-threatening injury occurs and the injured person cannot undergo decontamination procedures, the medical facility will be informed that the injured person has not been decontaminated and the facility will be given information regarding the most probable COPCs.

10 TRAINING REQUIREMENTS

Individuals performing work at locations where potentially hazardous materials and conditions may be encountered must meet specific training requirements. Training requirements consist of site-specific safety instruction for each facility through the Houston-Galveston Area Council for all personnel and oversight of inexperienced personnel for one working day, and site-specific orientation training at each facility. In addition, all personnel will have received a minimum of 40 hours of OSHA Hazardous Waste Operator (Hazwoper) off-site training for personnel involved in activities that have a potential for exposure to contaminated media (e.g., sediment sampling and decontamination). Any personnel involved in non-intrusive procedures (e.g., upland surveying) or who will not likely come in contact with contaminated media at the Site will have a minimum of 24 hours of OSHA Hazwoper off-site training. All training requirements must be kept current.

All personnel must read this HASP and be familiar with its contents before beginning work. They shall acknowledge reading the HASP by signing the field team HASP review form contained in Attachment B. The form will be kept in the project files and available for review on-site during the field work.

The Field Supervisor or a designee will provide and document project-specific training during the project kickoff meeting and whenever new workers arrive on site. Field personnel will not be allowed to begin work until project-specific training is completed and documented by the Field Supervisor. Training will address the HASP and all health and safety issues and procedures pertinent to field operations. Training will include, but not be limited to, the following topics:

- Activities with the potential for chemical exposure
- Activities that pose physical hazards, and actions to control the hazards
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of equipment
- Location of emergency equipment on the vessel
- Vessel safety practices.

10.1 Facility Specific Training

All personnel must obtain and abide by safety training as provided by each specific facility (Shell, Lubrizol, and OxyVinyls). The PM will maintain records detailing each worker's facility specific training.

10.2 Daily Safety Briefings

The Field Supervisor or a designee and the vessel operator will present safety briefings before the start of each day's activities. These safety briefings will outline the activities expected for the day, update work practices and hazards, address any specific concerns associated with the work location, and review emergency procedures and routes. The safety briefings will be documented in the logbook.

11 RECORDING AND RECORD KEEPING

The Field Supervisor or a designee will record health- and safety-related details of the project in the field logbook. The logbook must be bound and the pages must be numbered consecutively. Entries will be made with indelible ink. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all personnel
- Level of PPE worn and any other specifics regarding PPE
- Weather conditions
- Type of fieldwork being performed

The person maintaining the entries will initial and date the bottom of each completed page. Blank space at the bottom of an incompletely filled page will be lined out. Each day's entries will begin on the first blank page after the previous work day's entries.

As necessary, other documentation will be obtained or initiated by the Field Supervisor. Other documentation may include field change requests, medical and training records, exposure records, accident/incident report forms, OSHA Form 300s, and material safety data sheets.

12 EMERGENCY RESPONSE PLAN

As a result of the health and safety hazards associated with expected field activities, the potential exists for an emergency situation to occur. Emergencies may include personal injury, heat stroke, exposure to hazardous substances, fire, explosion, or release of toxic or non-toxic substances (spills). OSHA regulations require that an emergency response plan be available to guide actions in emergency situations.

Onshore organizations will be relied upon to provide response in emergency situations both onshore and on water. The local fire department and ambulance service can provide timely response. Each facility will likely have an incident response team that may provide emergency response. Anchor personnel and subcontractors will be responsible for identifying an emergency situation, providing first aid if applicable, notifying the appropriate personnel or agency, and evacuating any hazardous area. Shipboard personnel will attempt to control only very minor hazards that could present an emergency situation, such as a small fire, and will otherwise rely on outside emergency response resources.

The following sections address pre-emergency preparation, identify individual(s) who should be notified in case of emergency, provide a list of emergency telephone numbers, offer guidance for particular types of emergencies, and provide directions and a map for getting from any sampling location to a hospital.

12.1 Pre-Emergency Preparation

Before the start of field activities, the Field Supervisor will ensure that preparation has been made in anticipation of emergencies. Preparatory actions include the following:

- Notification of the POC at each plant when field crews/personnel will be working on or adjacent to their facility.
- Meeting with the vessel operators concerning the emergency procedures in the event that a person is injured. Appropriate actions for specific scenarios will be reviewed. These scenarios will be discussed and responses determined before the sampling event commences.
- A training session given by the vessel operator informing all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures.

- A training session to apprise field personnel of operating procedures and specific risks associated with any equipment that may pose a hazard.
- Ensuring that field personnel are aware of the existence of the emergency response plan, its location as Section 12 of the HASP, and ensuring that a copy of the HASP accompanies the field team(s).

12.2 Site Emergency Coordinator

The Field Supervisor will serve as the Project Emergency Coordinator in the event of an emergency. The Field Supervisor will designate a replacement for times when he or she is not serving as the Project Emergency Coordinator. The designation will be noted in the logbook. The PM will have responsibility for notifying the JDG representatives and the facility POCs.

12.3 Emergency Response Contacts

All personnel must know whom to notify in the event of an emergency situation, even though the Field Supervisor has primary responsibility for notification. Attachment A lists the names and phone numbers for emergency response services and individuals. If any accident or incident occurs, the following procedures will be utilized:

- The Field Supervisor or designated Project Emergency Coordinator will be notified immediately and will evaluate the incident to assess the need for emergency response.
- For incidents that do not require emergency response as determined by the Field Supervisor or designated Project Emergency Coordinator, the Field Supervisor will immediately notify the PM and all facility POCs (Section 1).
- For incidents that require emergency response, the Field Supervisor or designated Project Emergency Coordinator will activate emergency response according the following facility-specific procedures:
  - Shell Chemical and Shell Oil – Dial 911
  - OxyVinyls – Dial 911
  - Lubrizol – Dial facility emergency response (832-260-7590; Gate 14)
  - Once emergency response has been activated, the PM, HSM, and all facility POCs (Section 1) will be notified immediately.

12.4 Recognition of Emergency Situations

Emergency situations will generally be recognizable by observation. An injury or illness will be considered an emergency if it requires treatment by a medical professional and cannot be treated with simple first aid techniques.

12.5 Fire

Shipboard personnel will attempt to control only small fires, should they occur. If an explosion appears likely, personnel will follow evacuation procedures specified by the vessel operator in the training session. If a fire cannot be controlled with a fire extinguisher that is part of the required safety equipment on board, personnel will either withdraw from the vicinity of the fire, use additional fire fighting equipment, or evacuate the boat as specified by the vessel operator in the training session.

12.6 Personal Injury

In the event of serious personal injury, including unconsciousness, possibility of broken bones, severe bleeding or blood loss, burns, shock, or trauma, the first responder will immediately do the following:

- Administer first aid, if qualified
- If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit
- Notify the Project Emergency Coordinator of the incident, the name of the individual, the location, and the nature of the injury
- If an injury occurs on one of the plants or facilities, notify the appropriate POC for that facility

The Project Emergency Coordinator will immediately do the following:

- Notify the appropriate emergency response organization (e.g., 911 or the facility's emergency response number as described in Section 12.3) and arrange to meet the response unit at the nearest accessible location
- Assist the injured individual
- If the incident occurs on the boat, follow the emergency procedures for retrieving or disposing equipment reviewed in the training session and leave the Site en route to the predetermined land-based emergency pick-up
- Designate someone to accompany the injured individual to the hospital

- Notify the HSM and the PM

If the Project Emergency Coordinator determines that emergency response is not necessary, he or she may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions and a map showing the route to the hospital are provided in Figure 12-1.

If a worker leaves the Site to seek medical attention, another worker will accompany him or her to the hospital. When in doubt about the severity of an injury or exposure, always seek medical attention as a conservative approach and notify the Project Emergency Coordinator.

The Project Emergency Coordinator will have responsibility for completing all accident/incident field reports, OSHA Form 200s, and other required follow-up forms.

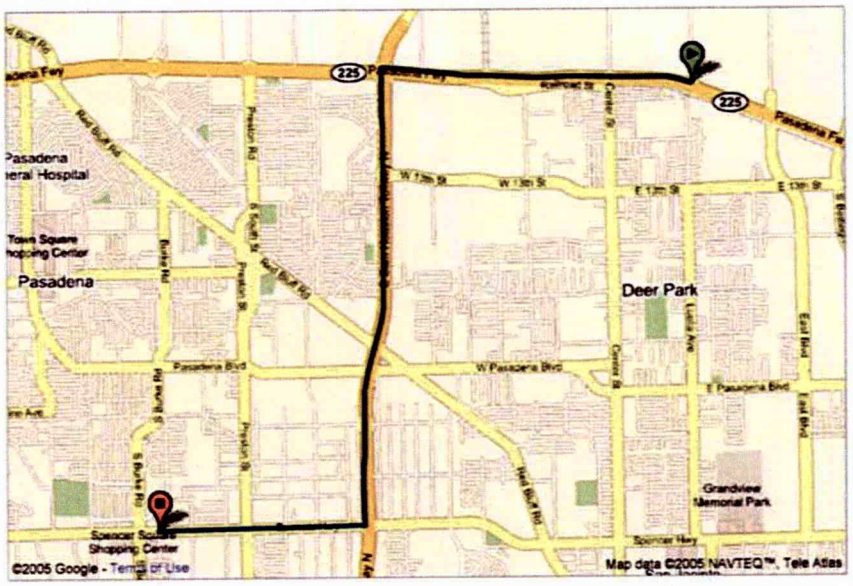
12.7 Overt Personal Exposure or Injury

Overt exposure to toxic materials is not expected to occur. Accordingly, an overt personal exposure procedure is not required.

12.8 Spills and Spill Containment

Sources of bulk chemicals or other materials subject to spillage are not expected to be used during this project. Accordingly, a spill containment procedure is not required for this project.

Google Maps BETA



Start address:	101 Tidal Rd Deer Park, TX 77536
End address:	4000 Spencer Hwy Pasadena, TX 77504
Distance:	7.4 mi (about 10 mins)

1. Head **west** from **TX-225** - go **0.2 mi**
2. Take the **TX-225 W** ramp - go **1.6 mi**
3. Take the exit to **Beltway 8/Toll Bridge** - go **0.2 mi**
4. Continue on **Pasadena Fwy** - go **0.5 mi**
5. Turn **left** at **E Beltway 8/E Sam Houston Pky S** - go **0.3 mi**
6. Take the **Sam Houston Tollway S** ramp - go **0.2 mi**
7. Merge into **E Sam Houston Tollway S** - go **2.2 mi**
8. Take the exit to **Spencer Hwy/Vista Rd** - go **0.3 mi**
9. Continue on **E Beltway 8/E Sam Houston Pky S** - go **0.3 mi**
10. Turn **right** at **Spencer Hwy** - go **1.6 mi**

These directions are for planning purposes only. You may find that construction projects, traffic, or other events may cause road conditions to differ from the map results.

http://maps.google.com/maps?saddr=41+Todal+Rd,+Deer+Park,+TX&daddr=4000+Spen... 5/10/2005

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 12-1
Map to the Nearest Hospital
Patrick Bayou RI Work Plan

13 HEALTH AND SAFETY PLAN APPROVAL RECORD

By their signature, the undersigned certify that this Health and Safety Plan is approved and that it will be used to govern health and safety aspects of fieldwork conducted by Anchor personnel to investigate areas associated with the Patrick Bayou Superfund Site Remedial Investigation/ Feasibility Study.

Anchor Project Health and Safety Manager Date

Anchor Field Supervisor Date

14 REFERENCES

Anchor. 2006a. Preliminary Site Characterization Report. Patrick Bayou Superfund Site, Deer Park, Texas. Prepared for USEPA and the Patrick Bayou Joint Defense Group. Prepared by Anchor Environmental, L.L.C. May 2006.

Anchor. 2006b. Response to Agency Comments on the Preliminary Site Characterization Report. Patrick Bayou Superfund Site, Deer Park, Texas. Prepared for USEPA and the Patrick Bayou Joint Defense Group. Prepared by Anchor Environmental, L.L.C. July 2006.

ATTACHMENT A

EMERGENCY AND PROJECT CONTACT INFORMATION

Anchor Project Manager:
David Keith
Phone: (228) 818-9626
Mobile: (251) 259-7197

Anchor Field Supervisor:
Jason Kase
Phone: (228) 818-9644
Mobile: (251) 259-7196

Anchor Health and Safety Manager:
Dennis Hanzlick
Phone: (206) 903-3317

Patrick Bayou Joint Defense Group Contacts:

Robert Piniewski – de maximis
Phone: (281) 363-8733
Mobile: (832) 567-7981

David Roberson
Phone: (281) 363-8733
Mobile: (281) 685-2044

Site Location Addresses:

Shell Chemical LP	Shell Oil	OxyVinyls	Lubrizol Corporation
Deer Park Chemical Plant	Deer Park Refining Services Co.	1000 Tidal Rd	41 Tidal Road
5900 Highway 225 East	5900 Hwy. 225	Deer Park, TX	Deer Park, TX
Deer Park, TX 77536	Deer Park, TX 77536	77536	77536-0158

Plant Emergency Contact Numbers:

Shell Chemical LP	Shell Oil	OxyVinyls	Lubrizol Corporation
Deer Park Chemical Plant	Deer Park Refining Services Co.	911	(832)260-7590
(713) 246-7301	(713) 246-7301		

Deer Park: 911

State Police: (512) 424-2000

U.S. Coast Guard

USCG Rescue Coordination Center: (504) 589-6225
Marine Safety Office Houston-Galveston: (713) 671-5100

TCEQ: 24-hr Notification Hotline 1-800-832-8224

Harris County Sheriff: (713) 221-6000

Poison Control: (800) 256-9822

Hospital: (713) 359-2000

Facility Point of Contacts:

Shell Chemical LP:	OxyVinyls:	Lubrizol Corporation:
Jeff Stevenson Phone: (713) 246-4680 Pager: (713) 606-4475	Jeff Adamski Phone: (281) 476-2628 Mobile: (281) 881-4892	Norman (Wes) Mollard Phone: (832) 260-7846 Mobile: (832) 689-6190

ATTACHMENT B

FIELD TEAM HEALTH AND SAFETY PLAN REVIEW

ANCHOR ENVIRONMENTAL, L.L.C.

I have read a copy of the Health and Safety Plan, which covers field activities that will be conducted to perform the Remedial Investigation/Feasibility Study of Patrick Bayou. I understand the health and safety requirements of the project, which are detailed in this Health and Safety Plan.

Printed Name and Title	Company/Firm	Signature	Date

ATTACHMENT C

DAILY HEALTH AND SAFETY MEETING CHECKLIST

Daily Health and Safety Meeting Checklist

Date	Site Manager/Safety Officer	Project Name	Project No.

MEDICAL TREATMENT AND FIRST AID

OK - for all on-site personnel

☐ - Nearest hospital, clinic, or infirmary routes known.
☐ - Emergency phone numbers posted in obvious location(s).
☐ - First aid kit easily accessible, stocked with appropriate supplies, and location known.
☐ - Emergency eyewash and/or shower available and location known.

TRAFFIC HAZARD PREVENTION

OK - for all on-site personnel

☐ - Traffic cones and barricade fencing available and in adequate supply.
☐ - High visibility orange safety vests available and being worn.
☐ - Exclusion zone around work area established.
☐ - Travel routes and potential issues with overhead pipe racks identified.
☐ - Rig masts lowered and secured before traveling.
☐ - Vehicle backing procedures discussed and understood.

FIRE HAZARD PREVENTION

OK - for all on-site personnel

☐ - Portable fire extinguishers available, visible, easily accessible and charged
☐ - Central alarms for fire and emergency signals (for site and facility) known and understood.

ELECTRICAL HAZARD PREVENTION

OK - for all on-site personnel

☐ - Equipment clear of overhead power lines; safe distance known* and maintained, wind effects accounted for.
☐ - Workers know to suspend drilling, lower mast (if possible) and move away from rigs during electrical storms.
☐ - Extension cords have ground plugs and ground fault protectors.
☐ - Indicators of buried power lines known (conduits, electrical man-ways, duct banks).
☐ - Indicators of electrical hazards known (arcing, humming, popping, sizzling sounds).

TOOL AND EQUIPMENT HAZARD PREVENTION

OK - for all on-site personnel

☐ - Personal protective equipment in (PPE) available and used.
☐ - Safe use and handling of tools and equipment reviewed.
☐ - Cord-connected electrically-operated tools/equipment grounded or of approved double insulated type.
☐ - Equipment safeguards discussed and in place.
☐ - Machinery, tools, equipment, hydraulic/pneumatic hoses etc. in good condition, not deteriorated or damaged.
☐ - Moving flywheels, fans and gears covered by protective shrouds or guards
☐ - Rope used on drill rig cat head in good condition and not burned, frayed, oily, or wet.
☐ - Drill rods, stacked pipe, augers, etc. stored to prevent rolling, sliding, or falling.
☐ - Boat safety equipment and procedures reviewed.
☐ - Pinch points marked or identified.
☐ - Eye protection worn when using striking tools.

SITE HAZARD PREVENTION

OK - for all on-site areas

☐ - Work area clean and orderly, access unobstructed.
☐ - Tripping hazards, holes, or pits covered, guarded and/or marked
☐ - Work surfaces dry or slip-resistant.
☐ - Water hoses, electrical cords, conduit, steel cables, hawsers, pipes, poles, etc. secured.
☐ - Open manholes, monitor wells, recovery system vaults, receptor trenches, etc. marked and protected.
☐ - Open excavations, trenches, test pits, uneven surfaces, low slung ropes etc. marked and protected.
☐ - Workers aware of and alert for flying objects.
☐ - Workers aware of proper lifting techniques, use of 2-man carry, equipment for lifting, moving stationary objects.
☐ - Drill cuttings and core materials removed quickly and not allowed to accumulate.
☐ - Drill cuttings drummed (or similarly contained) and promptly sealed and labeled.
☐ - Site situated so that train movements will not interfere with equipment or endanger personnel.
☐ - Rest break schedule reviewed and understood.
☐ - Drinking water available

Daily Health and Safety Meeting Checklist

ENVIRONMENTAL HAZARD PREVENTION

OK - for all on-site personnel

☐ - Heat index, work rest regiment, and fluid intake reviewed and understood.
☐ - Biohazards (mosquitoes, ants, snakes and poisonous plants, etc.) discussed and understood.

INDIVIDUAL WORKER/EMPLOYEE ALERTNESS TRIGGERS
(reviewed by site supervisor on a continuous basis)

OK - for all on-site personnel

☐ - Awareness of the effects of inadequate sleep on alertness and fatigue.
☐ - Awareness of the effects of general health and attitude (sick, healthy, interested, disinterested) on alertness.
☐ - Awareness of the importance of muscular flexibility for physical tasks.
☐ - Awareness of the effects of food intake on alertness.
☐ - Awareness of the effects of working extended periods under high noise levels on fatigue level.
☐ - Awareness of the effects of time of day on fatigue levels.

☐ - An afternoon safety meeting was conducted after the site lunch break.

Hazard Risk Assessments Reviewed

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

** Power line requirements - OSHA 29 CFR 1910.180. For energized power lines, the minimum clearance between any part of the mast and the nearest power line rated 50 kv or below, shall be 10 feet. Contact the local utility company for line ratings for your site. For energized power lines rated over 50 kv, the minimum clearance shall be 10 feet plus 0.4 inch for each 1 kv over 50 kv, or twice the length of the line insulator, whichever is less, but never less than 10 feet.*

ATTENDEES

Print Name	Signature

ATTACHMENT D

JOB SAFETY ANALYSIS SHEETS

Patrick Bayou Remedial Investigation/Feasibility Study	Job Safety Analysis (JSA) Health and Safety Plan (HASP)
Activity:	Analyzed by:

❶ Job Steps	❷ Potential Hazards	❸ Critical Actions/Controls